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Summary of Wear Metals Data

J.R. Simplot Co./Smoky Canyon Mine

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I. Introduction

In June of 1993, J.R. Simplot Company's Smoky Canyon Mine began a field trial of FPC-1® Fuel Performance Catalyst. The trial was designed to determine the effect of the catalyst upon fuel consumption, smoke emissions, oil soot levels and subsequent wear metals reduction.

Fuel consumption testing was conducted first using the Carbon Mass Balance technique with the equipment operating under steady-state engine conditions. Fuel consumption for the fleet tested was reduced on average by 8.79%. The following table shows the equipment tested and the percentage fuel consumption reduction for each individual piece of equipment:

Unit#	Type	Engine	RPM	%Change/Fuel Consumption
88	CAT 785 Haul Truck	3512	1800	- 7.70
91	CAT 785 Haul Truck	3512	1800	- 9.75
92	CAT 785 Haul Truck	3512	1800	-12.23
P10	CAT 16G Patrol	3406	1800	-11.01
P12*	CAT 16G Patrol	3406	1800	- 0.25

* P12 accumulated only approximately 80 hours of operation.
(The balance of equipment had accumulated between 500-700 hours)

Smoke density was also measured during the fuel consumption test using the Bacharach Smoke Spot Method. Again, under steady-state engine conditions, smoke density was reduced 14.5% after FPC-1® fuel treatment. This was consistent with the observations of mechanics and operators who indicated that smoke was less dense and lighter colored after treatment with FPC-1®.

II. Oil Analysis Study

The oil analysis required a much longer period of time, and is still underway. However, data compiled during the first 9 months indicate a definite reduction in wear metals and therefore engine wear.

The oil sample data provided begins in July 1992 and the analysis is being performed by the Chevron LIFE Program on samples drawn approximately every 250 hours of operation. The "baseline" oil sample data (untreated fuel) covers approximately 4,000 hours of equipment operation (7/92-6/93). The "treated" data covers a period of approximately 3,000 hours of equipment operation (7/93-2/94).

Prior oil analysis studies indicate soot and wear metals increase for a short period of time after initial FPC-1® treatment. Soot levels are not analyzed for or reported at Smoky Canyon (Total Solids are measured) and therefore could not be tracked. Wear metals did appear

J.R. Simplot Oil Study
Smoky Canyon Mine
5/2/94

II. (Cont.)
to increase briefly in some equipment immediately after treatment but then began to trend lower and in most cases are continuing to trend lower (See Table 1).

Of particular note is the effect of FPC-1® upon the rate of engine wear. The rate of engine wear can be calculated from the relationship between total iron in the oil sample (parts per million iron) and the number of hours the engine operated on the oil change when the oil sample was taken. The simple calculation reveals a parts per million iron per hour of engine operation (Fe ppm/hr). Table 1 below summarizes the wear rate data in terms of iron wear per hour of operation, and calculates a percent change over the base fuel:

Table 1: Average Rate of Iron Wear/Hour
(Fe ppm/hr)

Unit No.	Base Fuel	Treated Fuel (1)	% Change	Treated Fuel (2)	% Change
13870	.112	.109	- 2.7	.093	-17.0
13880	.134	.103	-23.1	.082	-38.8
13890	.099	.077	-19.8	.076	-20.8
13900	.164	.116	-29.3	.128	-22.0
13910	.112	.105	- 3.7	.090	-17.4
AVE>	**.124**	**.102**	**-17.7%**	**.094**	**-24.2%**
13920(3)		.105		.099	

Notes:
(1) Average of all data collected after FPC-1® treatment occurred in 6/93.
(2) Same as (1) except first 1200 hours of operation after treatment excluded as this is normal "carbon cleanup" period.
(3) Only two data points for baseline so valid comparison could not be made.

Oil analysis studies conducted earlier reveal FPC-1® not only reduces soot mass in the motor oil over the same oil change interval, but also soot particle size. The reduced mass and particle size would reduce abrasion and slow viscosity change.

A similar comparison was made on copper (Cu) wear metal levels. The data appears to be less consistent than the iron wear metals and there were several major "spikes" that occurred in several pieces of equipment both before and after treatment with FPC-1® (See data summary tables in Appendices). Per discussion with Glayd Christensen it was agreed that these spikes would be removed from the averages for a more valid comparison. The data in Table 2 below makes this comparison:

Table 2: Average Rate of Copper Wear/Hour
(Cu ppm/hr)

Unit No.	Base Fuel	Treated Fuel (1)	%Change	Treated Fuel (2)	% Change
13870	.038	.046	+21.0	.041	+ 7.9
13880	.093	.040	-57.0	.024	-74.2
13890	.125	.037	-68.1	.035	-69.8
13900	.143	.066	-53.8	.070	-51.0
13910	.081	.031	-61.2	.026	-67.5
AVE>	**.096**	**.044**	**-54.2%**	**.039**	**-59.4%**
13920(3)		.030		.028	

Notes:
(1) Average of all data collected after FPC-1® treatment occurred in 6/93.
(2) Same as (1) except first 1200 hours of operation after treatment excluded as this is normal "carbon cleanup" period.
(3) Only two data points for baseline so valid comparison could not be made.

III. Conclusion

The Simplot Smoky Canyon Mine wear metal study will be continued until the data shows stability has been reached in the motor oil between oil changes. However, the data generated to-date demonstrate a significant reduction in engine wear as evidenced by reductions in both iron (Fe) and copper (Cu) wear metal levels.

J. R. Simplot Oil Analysis
Smokey Canyon Mine
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Iron levels have been reduced up to 24.2% and copper levels have been reduced up to 59.4%. Further, in most cases the trend is one that appears to still be declining. For graphic representation of this see the charts in the Appendices.

J.R. SIMPLOT COMPANY
SMOKY CANYON MINE, AFTON, WY

Oil Analysis Summary

Unit #: **13870**
CAT 785 Haul Truck — Chevron Delo 400 MG 15W40

Date	Fe	Cu	Hr/Oil	Fe/Hr	Cu/Hr
7/21/92	95	40	862	.110	.046
8/10/92	34	12	250	.136	.048
8/24/92	7	3	250	.028	.012
9/28/92	41	11	250	.164	.044
10/29/92	50	14	500	.100	.028
11/18/92	30	8	250	.120	.032
12/08/92	24	5	234	.102	.021
1/08/93	29	6	250	.116	.024
1/25/93	21	5	250	.084	.020
2/08/93	85	41	- (no hours reported)		
-	24	13	(1) 250	.096	.052
3/05/93	27	11	250	.108	.044
3/30/93	31	15	250	.124	.060
4/17/93	32	15	250	.128	.060
5/15/93	36	306	250	.144	1.224 (2)
6/04/93	30	911	250	.120	3.644 (2)
FPC-1® Fuel Treatment(6/10/93)					
7/07/93	32	420	250	.128	1.680 (2)
8/11/93	33	19	250	.132	.076
8/22/93	27	11	250	.108	.044
9/18/93	40	209	250	.160	.836 (2)
10/07/93	32	596	250	.128	2.384 (2)
10/28/93	26	121	254	.102	.476 (2)
11/14/93	28	54	234	.120	.231 (2)
11/23/93	18	16	232	.078	.069
12/11/93	26	11	241	.108	.046
1/01/94	24	9	242	.099	.037
1/20/94	19	7	231	.082	.030
2/05/94	14	5	226	.062	.022

Averages		
Before Treatment=	.112	.038
After Treatment =	.109	.046
After Treatment with first 1200 hours removed=	.093	.041

(1) Assumed 250 hours on oil sample
(2) Not included in averages as they are "spikes" and obviously outside the statistical range of data.

J.R. SIMPLOT COMPANY
SMOKY CANYON MINE, AFTON, WY

Oil Analysis Summary

Unit #: 13880
CAT 785 Haul Truck — Chevron Delo 400 MG 15W40

Date	Fe	Cu	Hr/Oil	Fe/Hr	Cu/Hr
-	45	50	250	.180	.200
8/04/92	30	84	250	.120	.336 (2)
8/24/92	24	118	250	.096	.472 (2)
9/14/92	29	338	250	.116	1.352 (2)
9/28/92	26	185	250	.104	.740 (2)
10/24/92	44	71	238	.185	.298 (2)
11/16/92	37	37	250	.148	.148
12/04/92	38	23	443	.086	.052
12/28/92	31	13	(1) 250	.124	.052
2/11/93	40	31	250	.160	.124
3/05/93	26	14	250	.104	.056
3/26/93	41	31	250	.164	.124
4/12/93	34	22	228	.149	.096
5/01/93	33	22	250	.132	.088
5/27/93	36	24	250	.144	.096
FPC-1® Fuel Treatment(6/10/93)					
6/25/93	41	17	250	.164	.068
7/28/93	51	23	500	.102	.046
8/13/93	30	16	250	.120	.064
9/18/93	36	16	250	.144	.064
10/12/93	28	13	250	.112	.052
10/28/93	20	6	232	.086	.026
11/17/93	23	7	236	.097	.030
11/23/93	15	4	255	.059	.016
12/17/93	16	6	281	.057	.021
1/15/94	19	6	234	.081	.026
2/12/94	26	6	229	.114	.026

Averages		
Before Treatment=	.134	.093
After Treatment =	.103	.040
After Treatment with first 1200 hours removed=	.082	.024

(1) Assumed 250 hours on oil sample
(2) Not included in averages as they are "spikes" and obviously outside the statistical range of data.

J.R. SIMPLOT COMPANY
SMOKY CANYON MINE, AFTON, WY

Oil Analysis Summary

Unit #: **13890**
CAT 785 Haul Truck — Chevron Delo 400 MG 15W40

Date	Fe	Cu	Hr/Oil	Fe/Hr	Cu/Hr
7/09/92	33	29	250	.132	.116
7/09/92	32	68	250	.128	.272
8/02/92	24	34	250	.096	.136
8/24/92	32	28	250	.128	.112
9/08/92	27	20	250	.108	.080
10/03/92	29	38	259	.112	.147
10/12/92	23	67	250	.092	.268
11/09/92	23	76	250	.092	.304
11/18/92	19	60	250	.076	.240
12/21/92	19	26	250	.076	.104
1/12/93	21	15	250	.084	.060
2/01/93	14	10	250	.056	.040
2/22/93	23	10	250	.092	.040
3/17/93	24	8	259	.093	.031
4/12/93	27	16	(1) 250	.108	.064
4/29/93	27	12	250	.108	.048
5/22/93	27	14	250	.108	.056
	FPC-1® Fuel Treatment(6/10/93)				
7/01/93	15	5	250	.060	.020
7/20/93	25	14	250	.100	.056
8/11/93	19	5	(1) 250	.076	.020
8/16/93	21	14	250	.084	.056
8/27/93	19	12	250	.076	.048
9/18/93	18	11	250	.072	.044
10/03/93	18	11	226	.080	.049
10/24/93	18	9	243	.074	.037
11/18/93	19	8	239	.079	.033
12/04/93	21	9	225	.093	.040
12/29/93	20	10	232	.086	.043
1/15/94	14	6	227	.062	.026
2/10/94	18	4	226	.080	.018
3/01/94	14	6	243	.058	.025

Averages		
Before Treatment=	.099	.125
After Treatment =	.077	.037
After Treatment with first 1200 hours removed=	.076	.035

(1) Assumed 250 hours on oil sample

J.R. SIMPLOT COMPANY
SMOKY CANYON MINE, AFTON, WY

Oil Analysis Summary

Unit #: 13900
CAT 785 Haul Truck — Chevron Delo 400 MG 15W40

Date	Fe	Cu	Hr/Oil	Fe/Hr	Cu/Hr
7/31/92	45	272	250	.180	1.088 (2)
8/20/92	31	144	250	.124	.576 (2)
9/08/92	25	36	250	.100	.144
9/28/92	42	283	250	.168	1.132 (2)
10/24/92	40	155	250	.160	.620 (2)
11/16/92	38	47	250	.152	.188
12/04/92	32	19	(1) 250	.128	.076
12/21/92	31	20	250	.124	.080
1/11/93	24	20	250	.096	.080
2/01/93	36	28	250	.144	.112
3/05/93	45	30	250	.180	.120
4/12/93	78	73	233	.335	.313
5/01/93	49	46	250	.196	.184
5/22/93	48	46	250	.192	.184
6/10/93	47	24	250	.188	.096
	FPC-1® Fuel Treatment (6/10/93)				
6/21/93	22	12	250	.088	.048
6/25/93	14	6	250	.056	.024
7/20/93	38	28	250	.152	.112
7/24/93	14	10	250	.056	.040
8/22/93	32	18	250	.128	.072
9/18/93	28	23	250	.112	.092
10/07/93	34	28	250	.136	.112
10/24/93	24	12	213	.113	.056
11/17/93	29	13	262	.111	.050
11/23/93	14	8	257	.054	.031
12/17/93	30	16	251	.120	.064
1/07/94	31	14	241	.129	.058
2/19/94	56	22	225	.249	.098

Averages		
Before Treatment=	.164	.143
After Treatment =	.116	.066
After Treatment with first 1200 hours removed=	.128	.070

(1) Assumed 250 hours on oil sample
(2) Not included in averages as they are "spikes" and obviously outside the statistical range of data.

J.R. SIMPLOT COMPANY
SMOKY CANYON MINE, AFTON, WY

Oil Analysis Summary

Unit #: 13910
CAT 785 Haul Truck — Chevron Delo 400 MG 15W40

Date	Fe	Cu	Hr/Oil	Fe/Hr	Cu/Hr
7/01/92	28	13	250	.112	.052
-	28	14	239	.117	.058
8/10/92	20	11	250	.080	.044
8/31/92	21	12	250	.084	.048
9/17/92	21	10	250	.084	.040
10/29/92	32	629	250	.128	2.516 (2)
11/18/92	27	247	250	.108	.988 (2)
12/14/92	20	45	230	.087	.196
2/01/93	39	43	250	.156	.172
2/19/93	20	19	250	.080	.076
3/22/93	26	97	250	.104	.388 (2)
4/02/93	27	23	250	.108	.092
4/26/93	40	20	250	.160	.080
5/17/93	35	18	250	.140	.072
6/07/93	34	11	250	.136	.044
FPC-1® Fuel Treatment(6/10/93)					
6/25/93	32	9	250	.128	.036
8/3/93	62	<1	500	.124	.002
8/16/93	29	149	250	.116	.596 (2)
9/04/93	36	63	250	.144	.252 (2)
9/28/93	33	22	250	.132	.088
10/07/93	24	11	250	.096	.044
10/24/93	20	7	231	.086	.030
11/14/93	20	9	234	.085	.022
11/28/93	20	5	225	.089	.029
12/26/93	29	7	239	.121	.017
1/15/94	17	4	234	.073	.017
1/29/94	12	3	250	.048	.012
2/18/94	27	5	225	.120	.022

Averages		
Before Treatment=	.112	.081
After Treatment =	.105	.031
After Treatment with first 1200 hours removed=	.090	.026

(1) Assumed 250 hours on oil sample
(2) Not included in averages as they are "spikes" and obviously outside the statistical range of data.

J.R. SIMPLOT COMPANY
SMOKY CANYON MINE, AFTON, WY

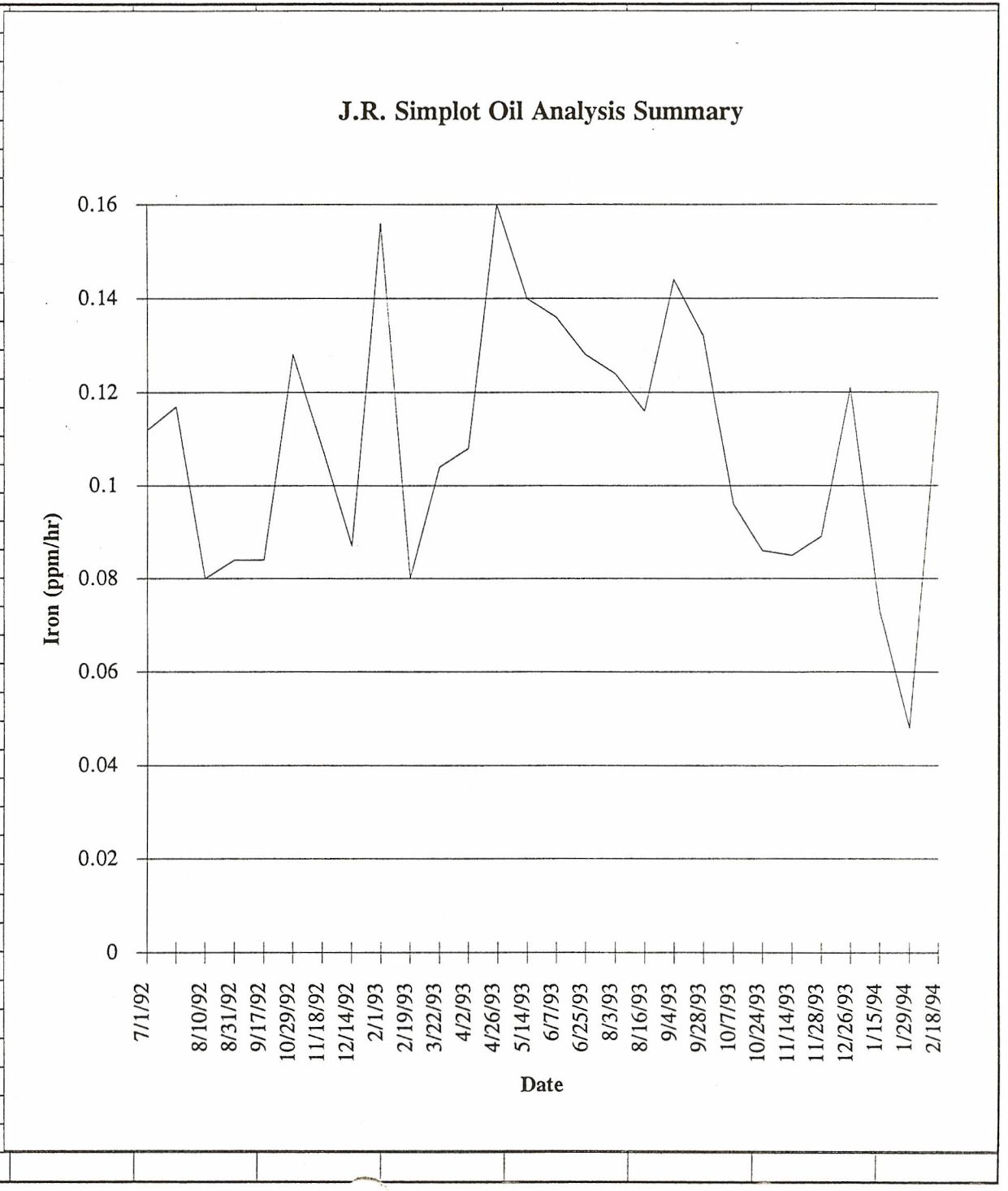
Oil Analysis Summary

Unit #: 13920
CAT 785 Haul Truck

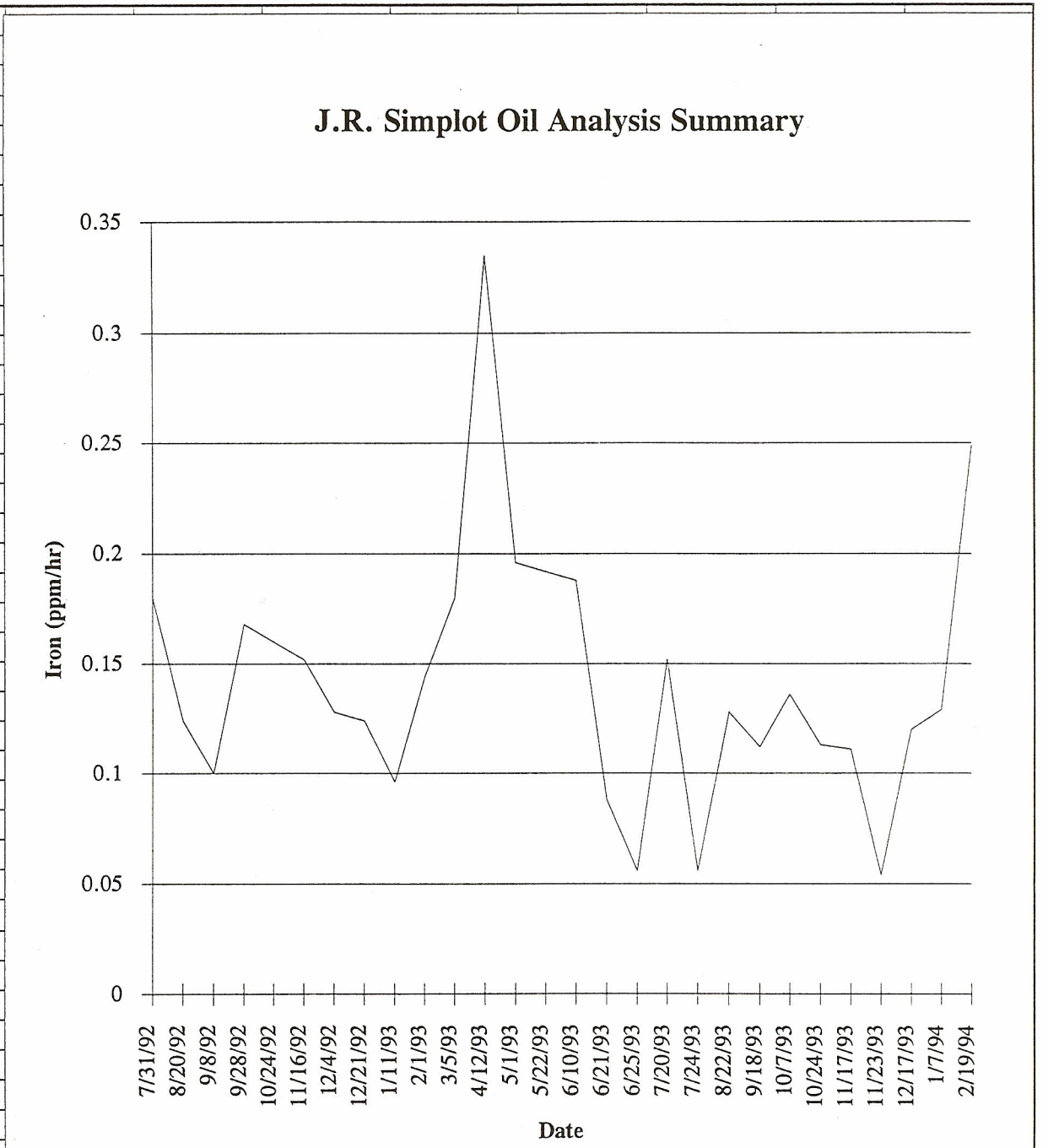
Chevron Delo 400 MG 15W40

Date	Fe	Cu	Hr/Oil	Fe/Hr	Cu/Hr
3/26/93	31	98	250	.124	.392
4/17/93	33	32	250	.132	.128
	FPC-1® Fuel Treatment(6/10/93)				
6/21/93	21	7	250	.084	.028
7/07/93	26	8	250	.104	.032
7/24/93	37	14	250	.148	.056
8/11/93	23	6	250	.092	.024
8/27/93	37	8	250	.148	.032
9/18/93	35	8	250	.140	.032
10/12/93	29	7	250	.116	.028
10/24/93	21	5	205	.102	.024
11/07/93	22	7	246	.089	.028
11/22/93	18	5	230	.078	.022
12/26/93	31	10	231	.134	.043
1/15/94	17	6	242	.070	.025
2/03/94	16	5	234	.068	.021
2/19/94	23	7	237	.097	.029

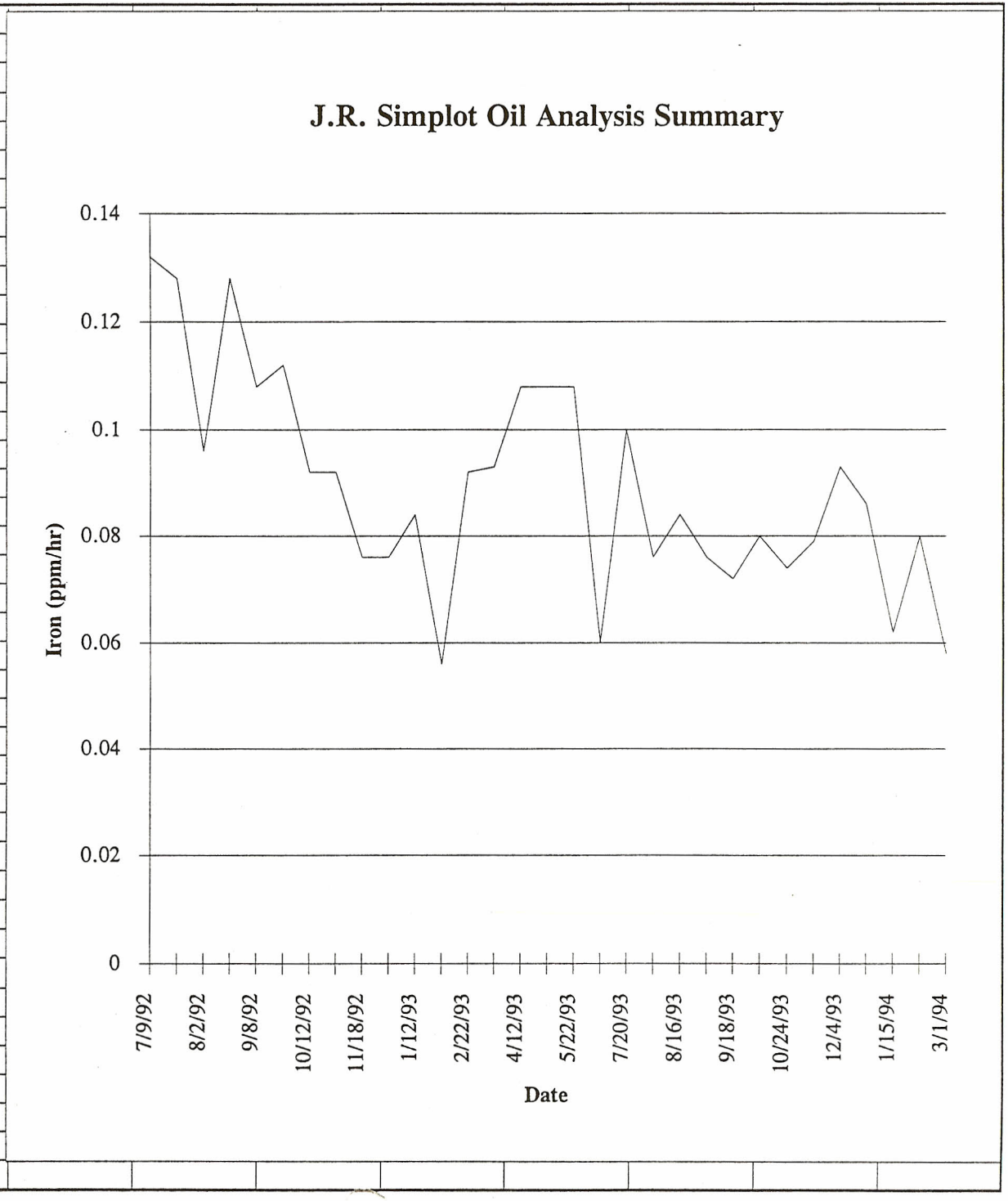
Unit # 13910 CAT 785 Haul Truck Date:	Iron:	
7/1/92	0.112	
	0.117	
8/10/92	0.08	
8/31/92	0.084	
9/17/92	0.084	
10/29/92	0.128	
11/18/92	0.108	
12/14/92	0.087	
2/1/93	0.156	
2/19/93	0.08	
3/22/93	0.104	
4/2/93	0.108	
4/26/93	0.16	
5/14/93	0.14	
6/7/93	0.136	
6/25/93	0.128	
8/3/93	0.124	
8/16/93	0.116	
9/4/93	0.144	
9/28/93	0.132	
10/7/93	0.096	
10/24/93	0.086	
11/14/93	0.085	
11/28/93	0.089	
12/26/93	0.121	
1/15/94	0.073	
1/29/94	0.048	
2/18/94	0.12	
	0.108785714	Mean
	0.027025855	ST Dev



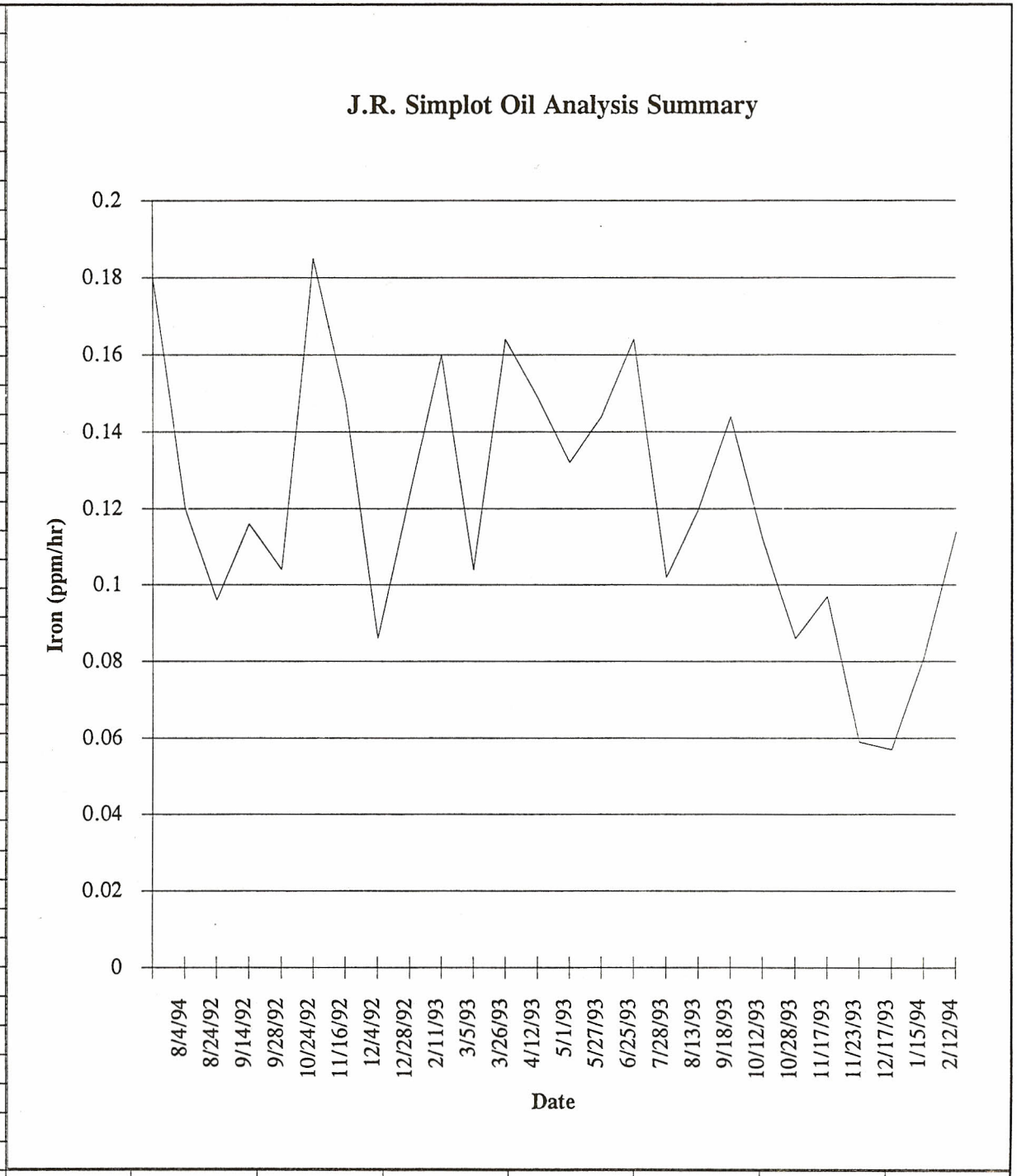
Unit # 13900 CAT 785 Haul Truck Date:	Iron (ppm/hr)	
7/31/92	0.18	
8/20/92	0.124	
9/8/92	0.1	
9/28/92	0.168	
10/24/92	0.16	
11/16/92	0.152	
12/4/92	0.128	
12/21/92	0.124	
1/11/93	0.096	
2/1/93	0.144	
3/5/93	0.18	
4/12/93	0.335	
5/1/93	0.196	
5/22/93	0.192	
6/10/93	0.188	
6/21/93	0.088	
6/25/93	0.056	
7/20/93	0.152	
7/24/93	0.056	
8/22/93	0.128	
9/18/93	0.112	
10/7/93	0.136	
10/24/93	0.113	
11/17/93	0.111	
11/23/93	0.054	
12/17/93	0.12	
1/7/94	0.129	
2/19/94	0.249	
	0.141821429	Mean
	0.059030471	ST Dev



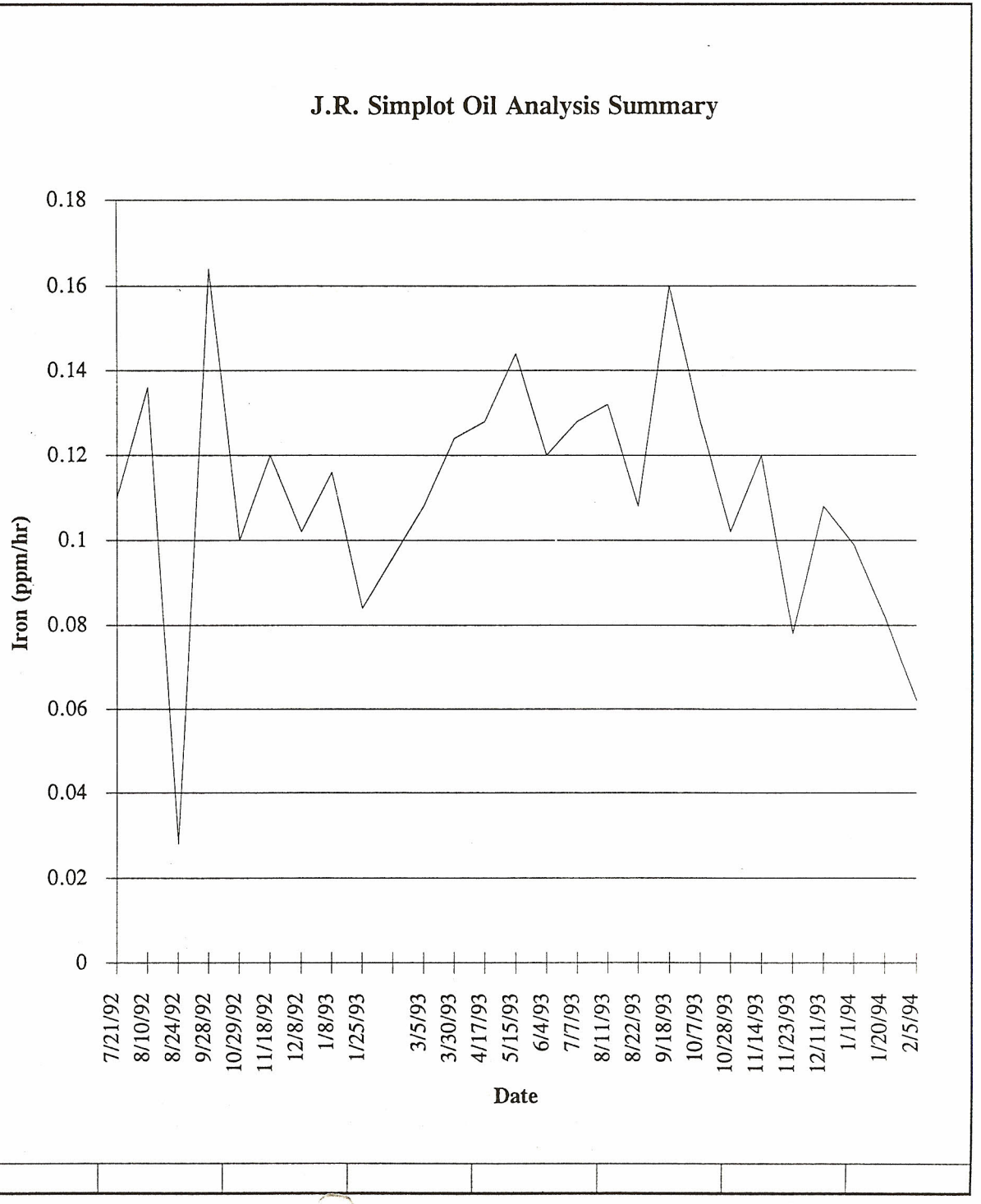
Unit # 13890 CAT 785 Haul Truck Date:	Iron (ppm/hr)	
7/9/92	0.132	
7/23/92	0.128	
8/2/92	0.096	
8/24/92	0.128	
9/8/92	0.108	
10/3/92	0.112	
10/12/92	0.092	
9-Nov	0.092	
11/18/92	0.076	
12/21/92	0.076	
1/12/93	0.084	
2/1/93	0.056	
2/22/93	0.092	
3/17/93	0.093	
4/12/93	0.108	
4/29/93	0.108	
5/22/93	0.108	
7/1/93	0.06	
7/20/93	0.1	
8/11/93	0.076	
8/16/93	0.084	
8/27/93	0.076	
9/18/93	0.072	
10/3/93	0.08	
10/24/93	0.074	
11/18/93	0.079	
12/4/93	0.093	
12/29/93	0.086	
1/15/94	0.062	
2/10/94	0.08	
3/1/94	0.058	
	0.086178571	Mean
	0.017828511	ST Dev



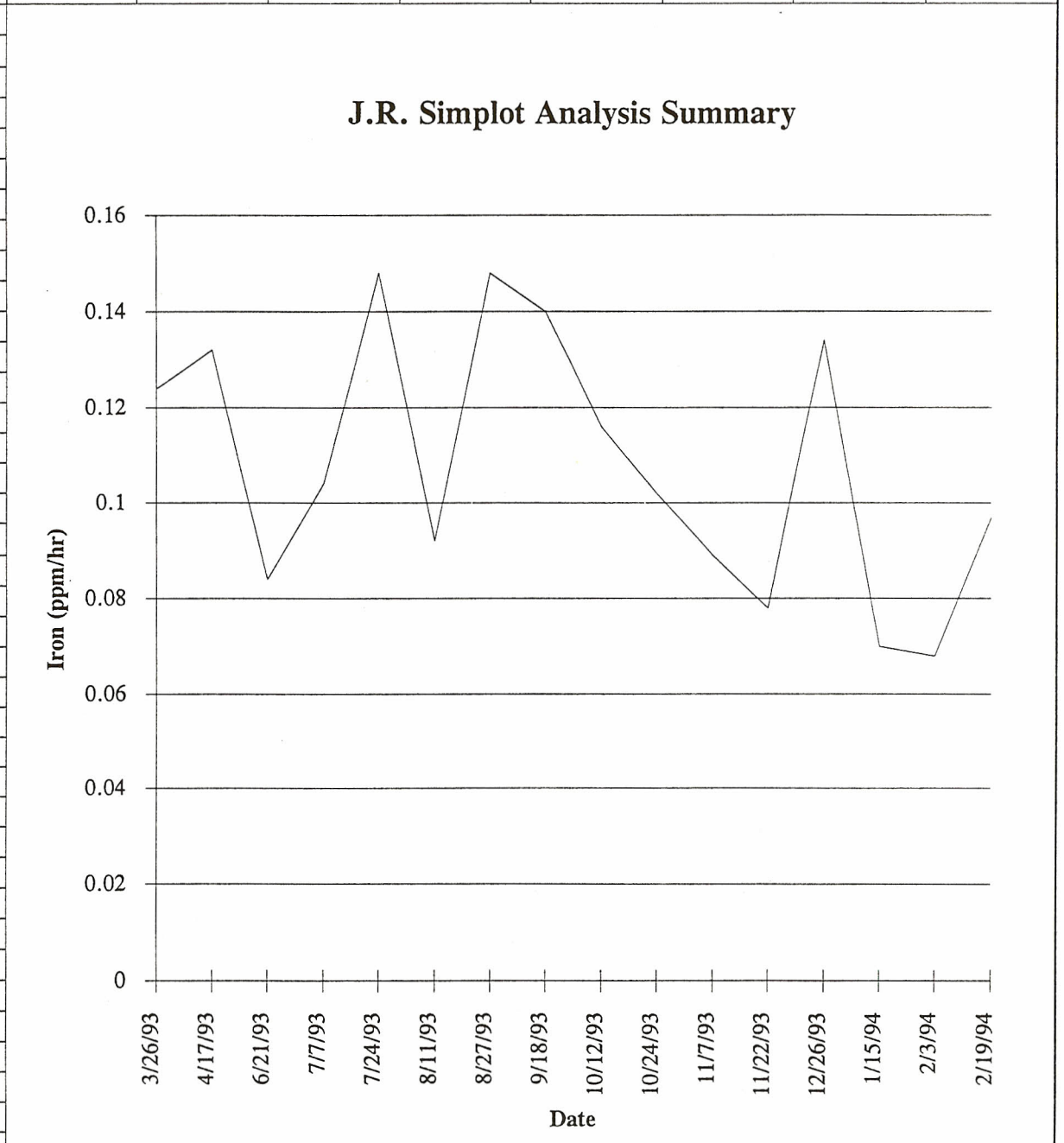
Unit # 13880 CAT 785 Haul Truck Date:	Iron (ppm/hr)	
	0.18	
8/4/94	0.12	
8/24/92	0.096	
9/14/92	0.116	
9/28/92	0.104	
10/24/92	0.185	
11/16/92	0.148	
12/4/92	0.086	
12/28/92	0.124	
2/11/93	0.16	
3/5/93	0.104	
3/26/93	0.164	
4/12/93	0.149	
5/1/93	0.132	
5/27/93	0.144	
6/25/93	0.164	
7/28/93	0.102	
8/13/93	0.12	
9/18/93	0.144	
10/12/93	0.112	
10/28/93	0.086	
11/17/93	0.097	
11/23/93	0.059	
12/17/93	0.057	
1/15/94	0.081	
2/12/94	0.114	
	0.121076923	Mean
	0.034515994	ST Dev



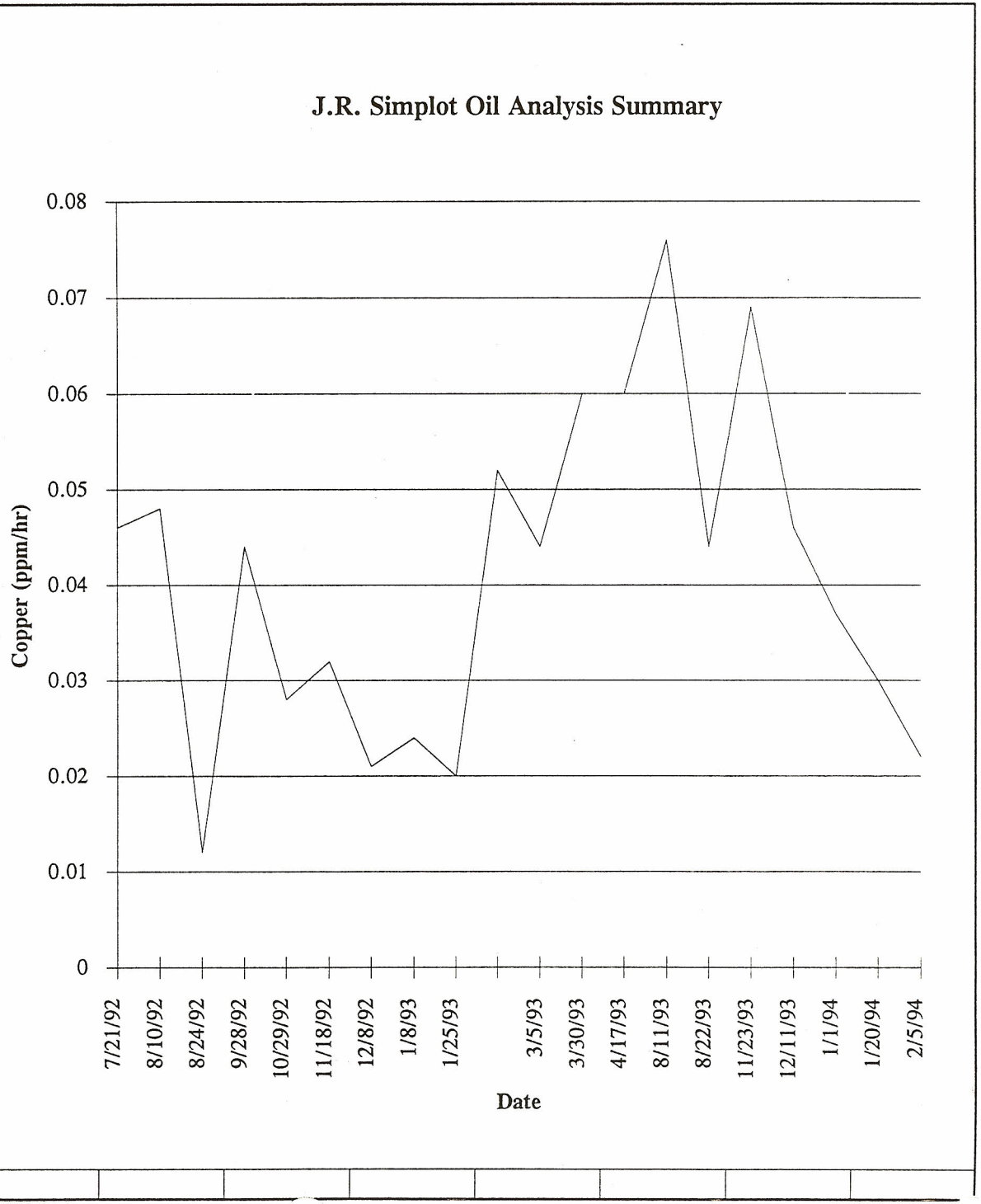
Unit # 13870		
CAT 785 Haul Truck		
Date:	Iron (ppm/hr)	
7/21/92	0.11	
8/10/92	0.136	
8/24/92	0.028	
9/28/92	0.164	
10/29/92	0.1	
11/18/92	0.12	
12/8/92	0.102	
1/8/93	0.116	
1/25/93	0.084	
	0.096	
3/5/93	0.108	
3/30/93	0.124	
4/17/93	0.128	
5/15/93	0.144	
6/4/93	0.12	
7/7/93	0.128	
8/11/93	0.132	
8/22/93	0.108	
9/18/93	0.16	
10/7/93	0.128	
10/28/93	0.102	
11/14/93	0.12	
11/23/93	0.078	
12/11/93	0.108	
1/1/94	0.099	
1/20/94	0.082	
2/5/94	0.062	
	0.11062963	Mean
	0.028618375	ST Dev



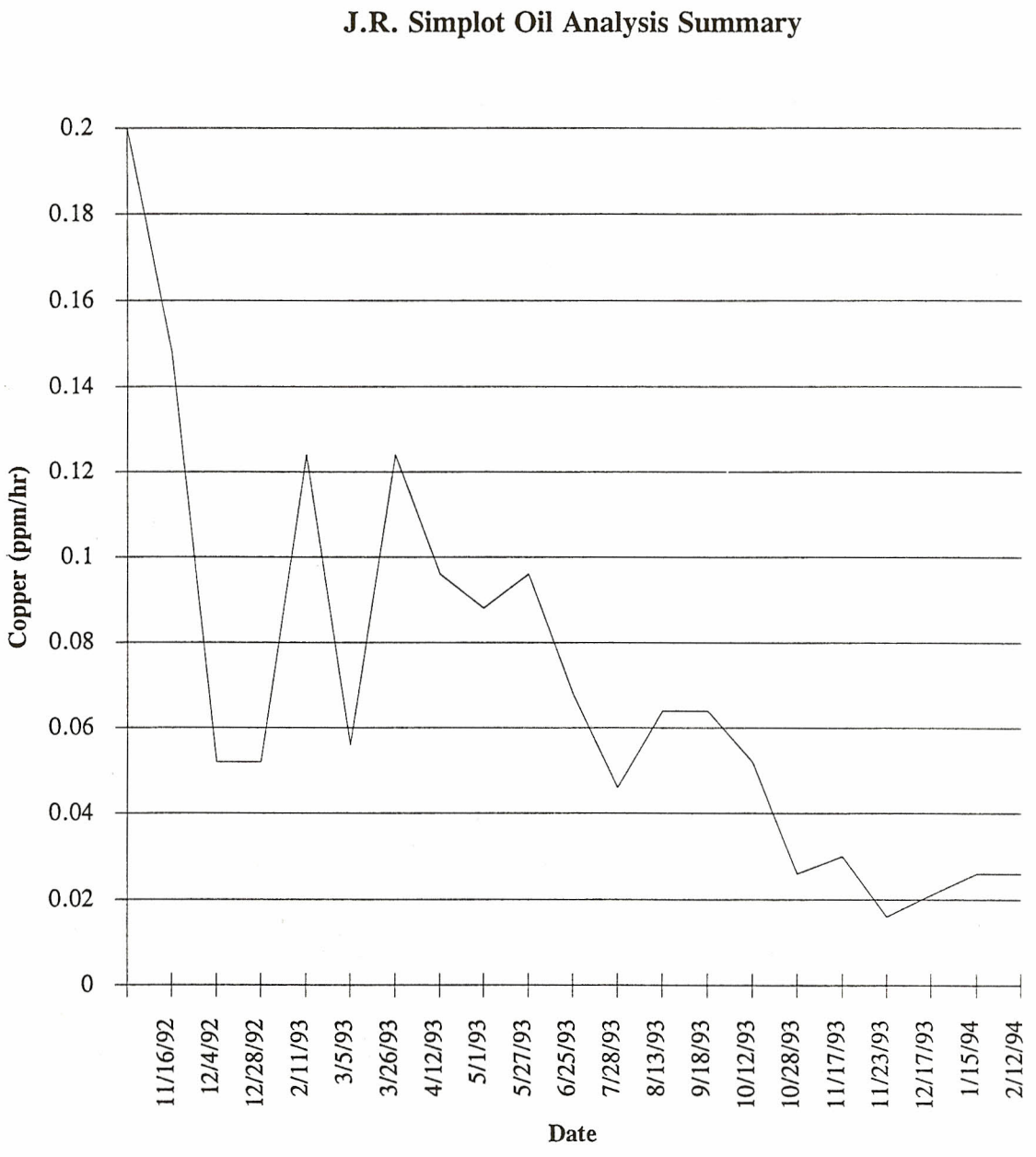
Unit # 13920 CAT 785 Haul Truck Date:	Iron:	
3/26/93	0.124	
4/17/93	0.132	
6/21/93	0.084	
7/7/93	0.104	
7/24/93	0.148	
8/11/93	0.092	
8/27/93	0.148	
9/18/93	0.14	
10/12/93	0.116	
10/24/93	0.102	
11/7/93	0.089	
11/22/93	0.078	
12/26/93	0.134	
1/15/94	0.07	
2/3/94	0.068	
2/19/94	0.097	
	0.103119168	Mean
	0.032842264	ST Dev



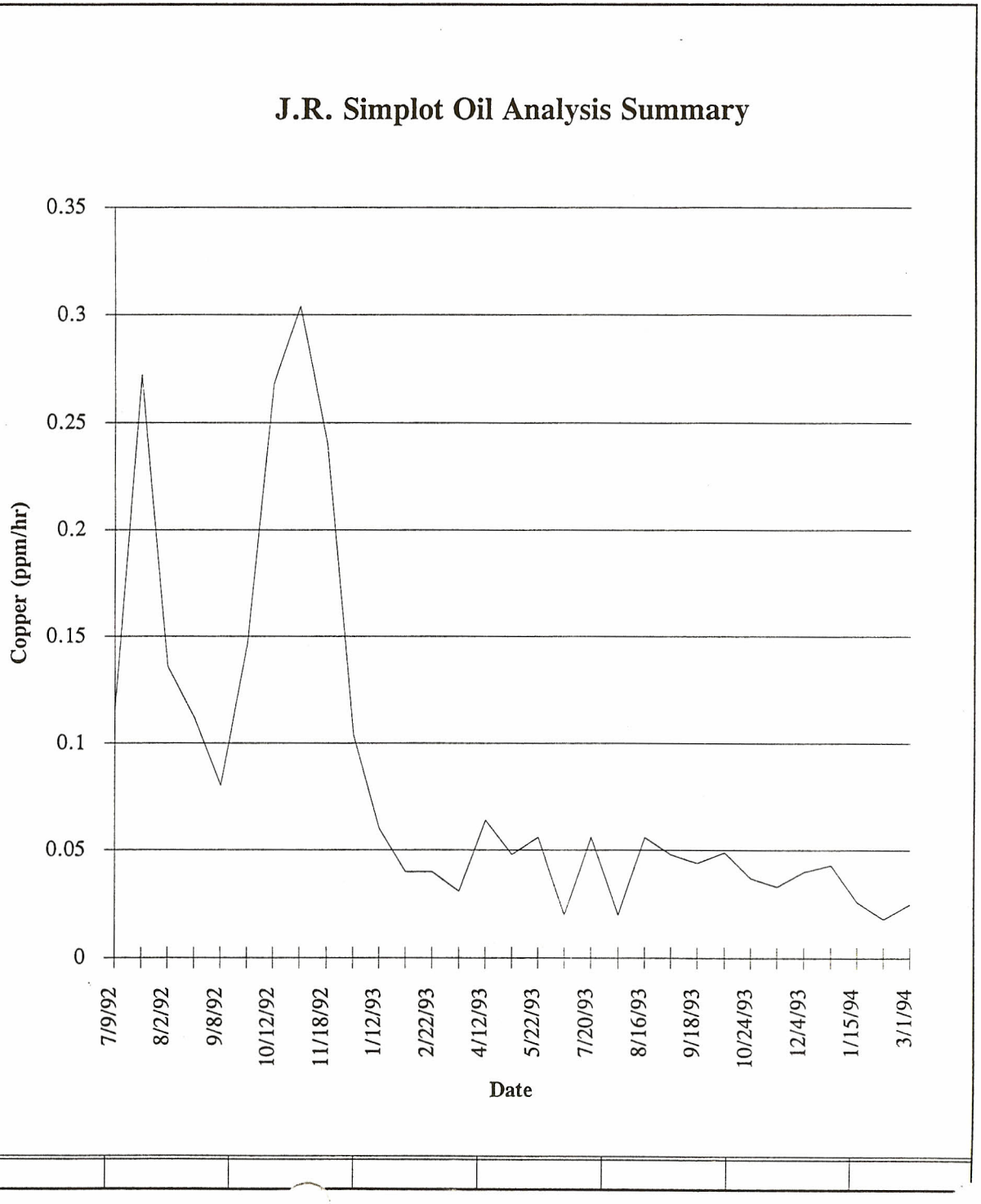
Unit # 13870 CAT 785 Haul Truck Date:	Copper (ppm/hr)	
7/21/92	0.046	
8/10/92	0.048	
8/24/92	0.012	
9/28/92	0.044	
10/29/92	0.028	
11/18/92	0.032	
12/8/92	0.021	
1/8/93	0.024	
1/25/93	0.02	
	0.052	
3/5/93	0.044	
3/30/93	0.06	
4/17/93	0.06	
8/11/93	0.076	
8/22/93	0.044	
11/23/93	0.069	
12/11/93	0.046	
1/1/94	0.037	
1/20/94	0.03	
2/5/94	0.022	
	0.04075	Mean
	0.01731405	ST Dev



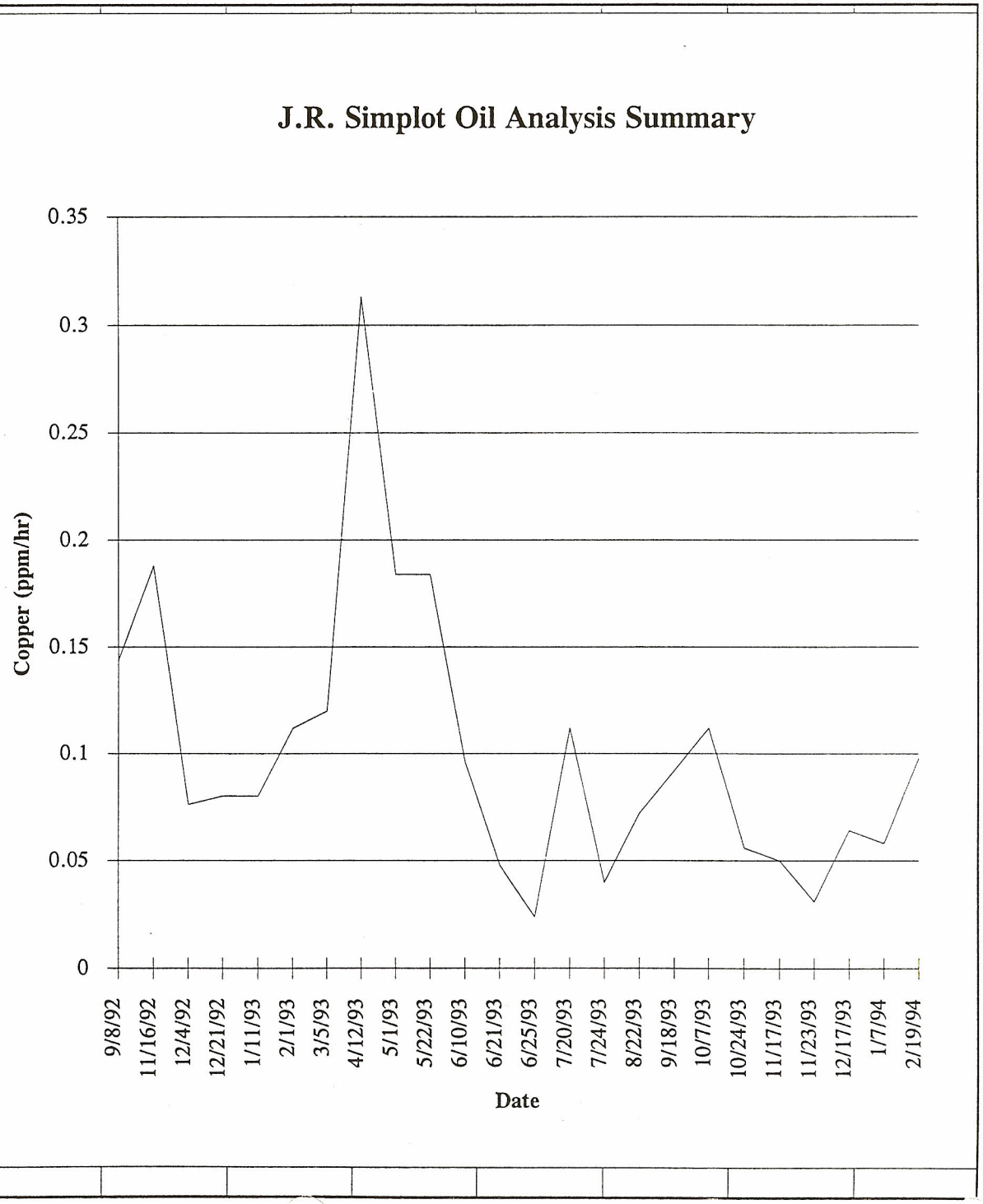
Unit # 13880 CAT 785 Haul Truck Date:	Copper (ppm/hr)	
	0.2	
11/16/92	0.148	
12/4/92	0.052	
12/28/92	0.052	
2/11/93	0.124	
3/5/93	0.056	
3/26/93	0.124	
4/12/93	0.096	
5/1/93	0.088	
5/27/93	0.096	
6/25/93	0.068	
7/28/93	0.046	
8/13/93	0.064	
9/18/93	0.064	
10/12/93	0.052	
10/28/93	0.026	
11/17/93	0.03	
11/23/93	0.016	
12/17/93	0.021	
1/15/94	0.026	
2/12/94	0.026	
	0.070238095	Mean
	0.047453034	ST Dev



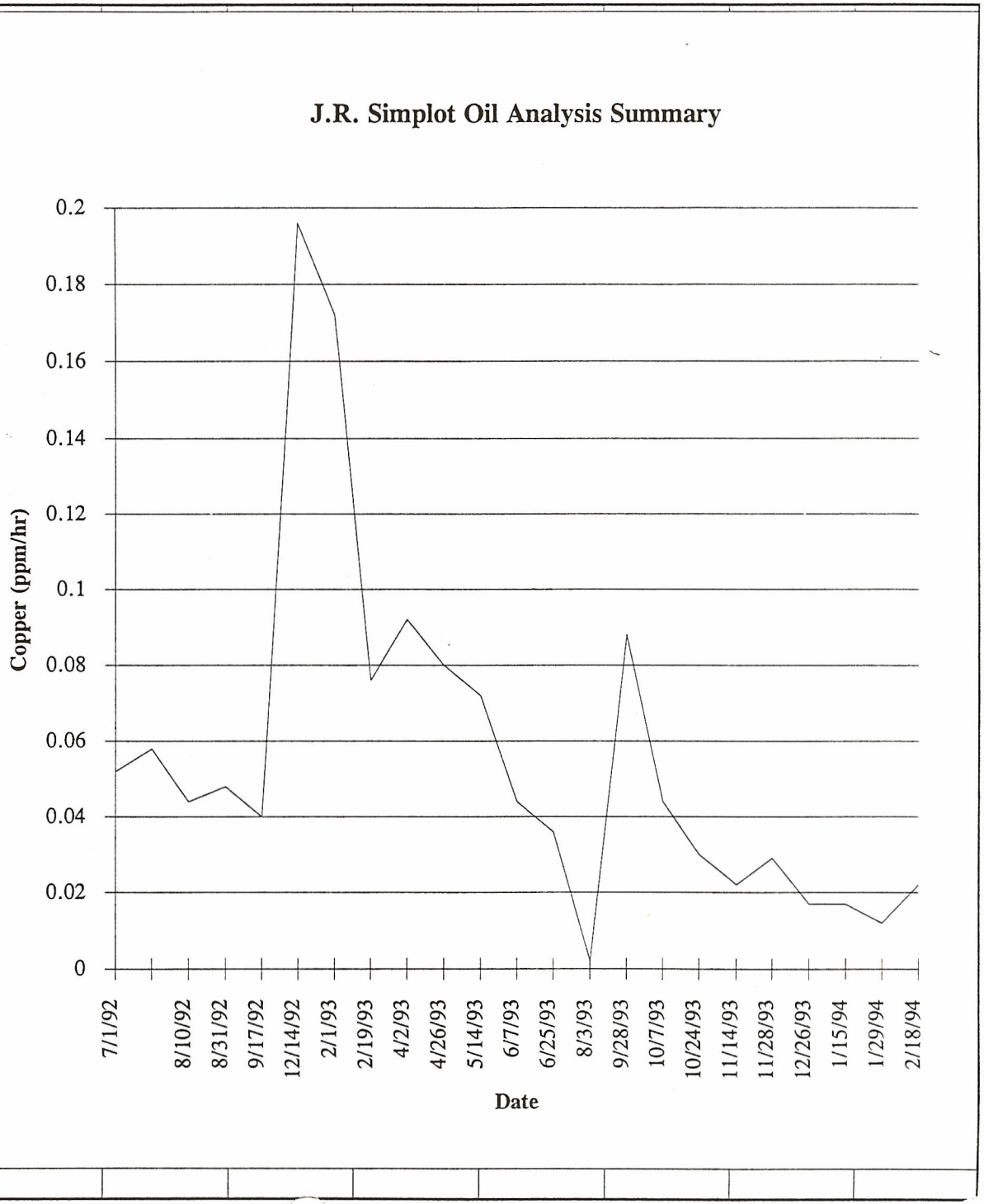
Unit # 13890 CAT 785 Haul Truck Date:	Copper (ppm/hr)	
7/9/92	0.116	
7/23/92	0.272	
8/2/92	0.136	
8/24/92	0.112	
9/8/92	0.08	
10/3/92	0.147	
10/12/92	0.268	
11/9/92	0.304	
11/18/92	0.24	
12/21/92	0.104	
1/12/93	0.06	
2/1/93	0.04	
2/22/93	0.04	
3/17/93	0.031	
4/12/93	0.064	
4/29/93	0.048	
5/22/93	0.056	
7/1/93	0.02	
7/20/93	0.056	
8/11/93	0.02	
8/16/93	0.056	
8/27/93	0.048	
9/18/93	0.044	
10/3/93	0.049	
10/24/93	0.037	
11/18/93	0.033	
12/4/93	0.04	
12/29/93	0.043	
1/15/94	0.026	
2/10/94	0.018	
3/1/94	0.025	
	0.075321429	Mean
	0.075252195	ST Dev



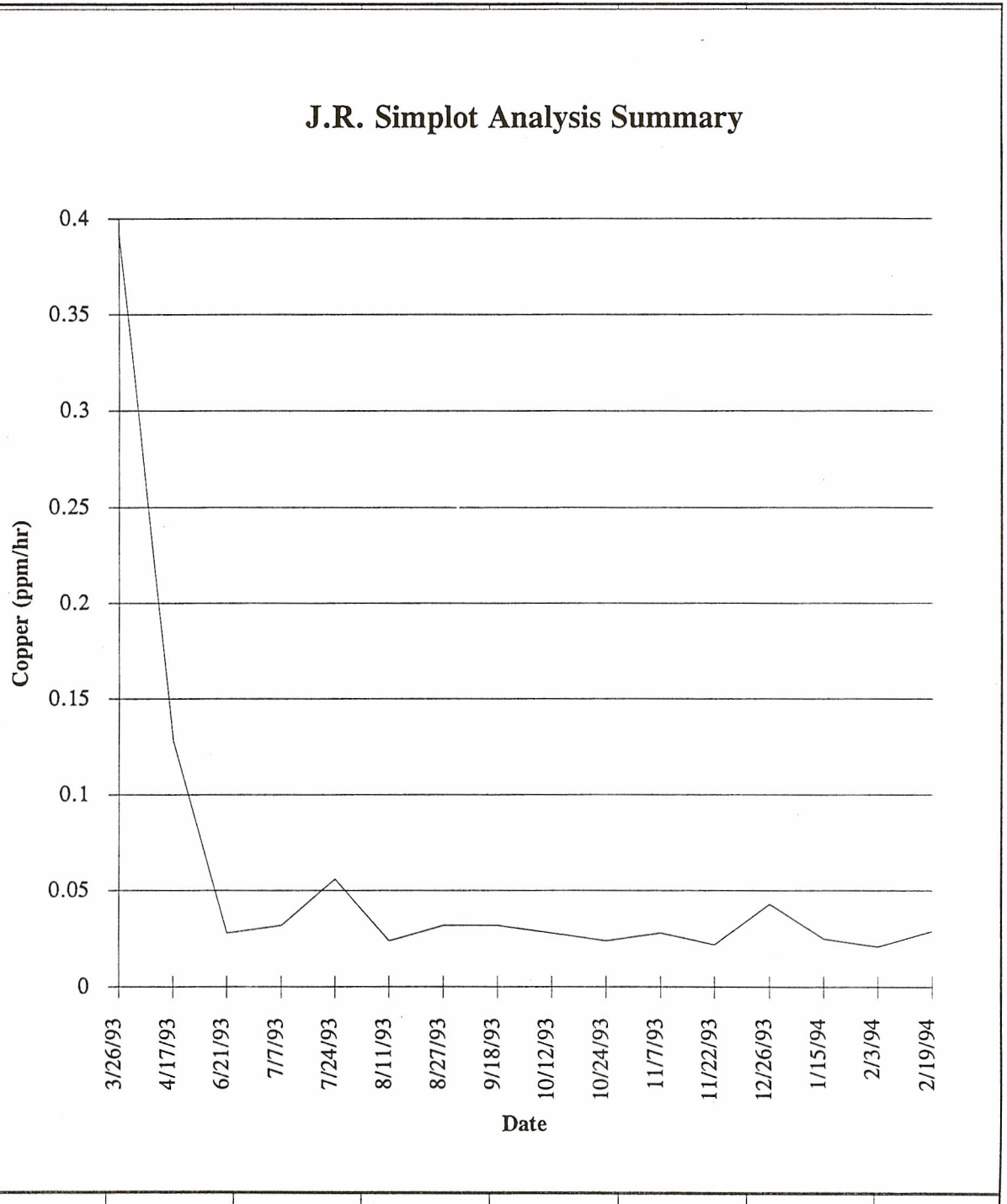
Unit # 13900 CAT 785 Haul Truck Date:	Copper (ppm/hr)	
9/8/92	0.144	
11/16/92	0.188	
12/4/92	0.076	
12/21/92	0.08	
1/11/93	0.08	
2/1/93	0.112	
3/5/93	0.12	
4/12/93	0.313	
5/1/93	0.184	
5/22/93	0.184	
6/10/93	0.096	
6/21/93	0.048	
6/25/93	0.024	
7/20/93	0.112	
7/24/93	0.04	
8/22/93	0.072	
9/18/93	0.092	
10/7/93	0.112	
10/24/93	0.056	
11/17/93	0.05	
11/23/93	0.031	
12/17/93	0.064	
1/7/94	0.058	
2/19/94	0.098	
	0.101416667	Mean
	0.064782524	ST Dev



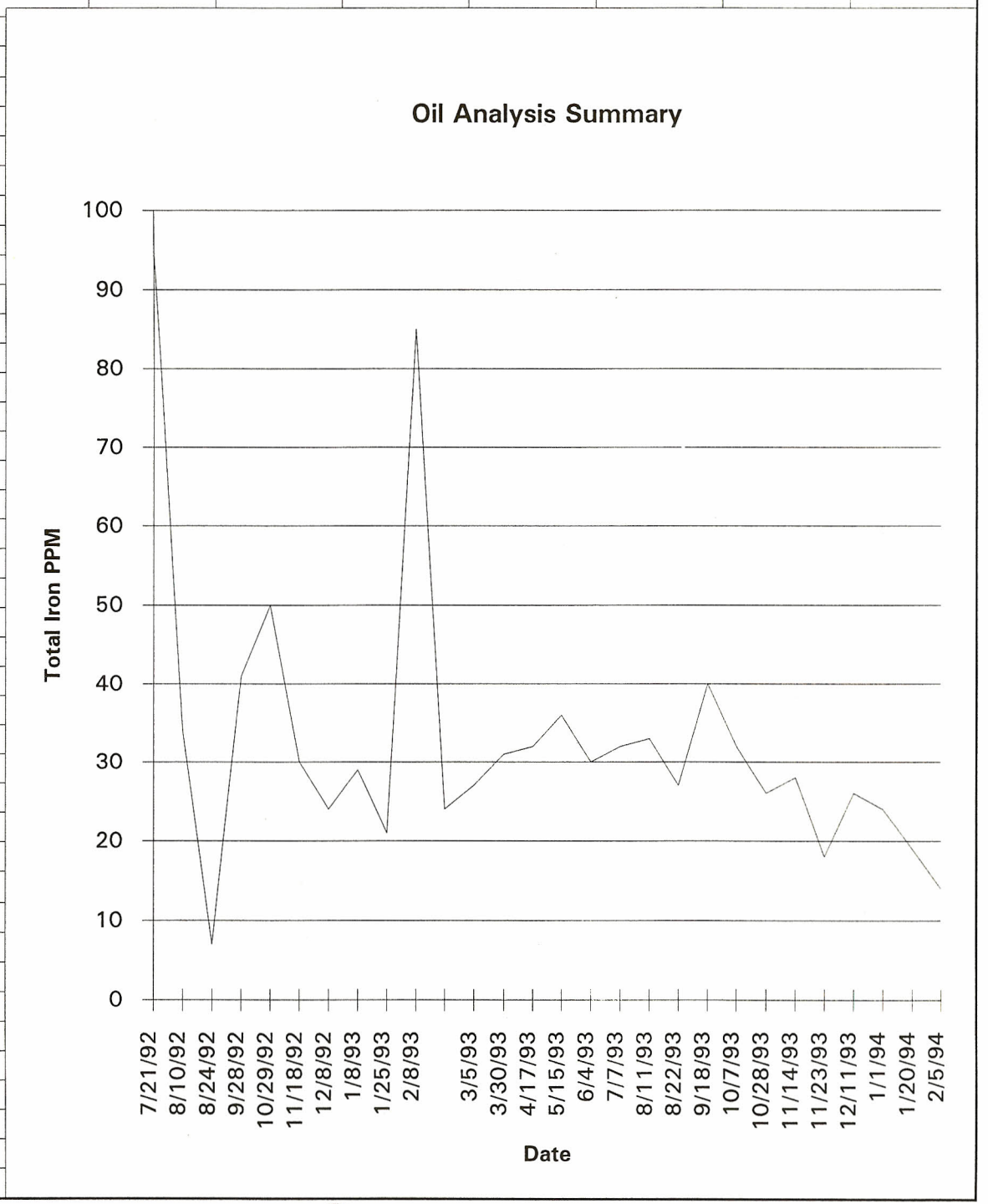
Unit # 13910 CAT 785 Haul Truck Date:	Copper (ppm/hr)	
7/1/92	0.052	
	0.058	
8/10/92	0.044	
8/31/92	0.048	
9/17/92	0.04	
12/14/92	0.196	
2/1/93	0.172	
2/19/93	0.076	
4/2/93	0.092	
4/26/93	0.08	
5/14/93	0.072	
6/7/93	0.044	
6/25/93	0.036	
8/3/93	0.002	
9/28/93	0.088	
10/7/93	0.044	
10/24/93	0.03	
11/14/93	0.022	
11/28/93	0.029	
12/26/93	0.017	
1/15/94	0.017	
1/29/94	0.012	
2/18/94	0.022	
	0.056217391	Mean
	0.047381389	ST Dev



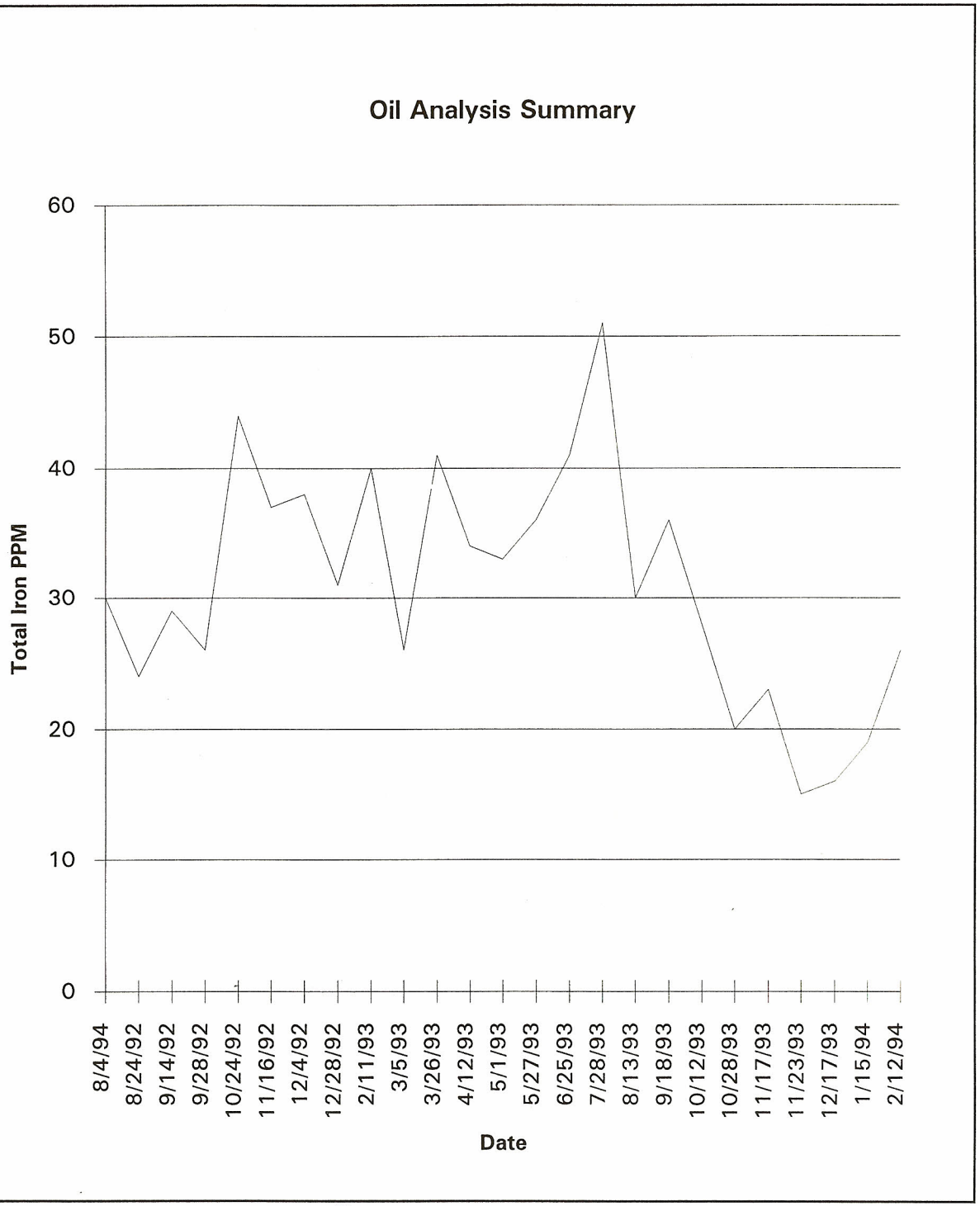
Unit # 13920 CAT 785 Haul Truck Date:	Copper (ppm/hr)	
3/26/93	0.392	
4/17/93	0.128	
6/21/93	0.028	
7/7/93	0.032	
7/24/93	0.056	
8/11/93	0.024	
8/27/93	0.032	
9/18/93	0.032	
10/12/93	0.028	
10/24/93	0.024	
11/7/93	0.028	
11/22/93	0.022	
12/26/93	0.043	
1/15/94	0.025	
2/3/94	0.021	
2/19/94	0.029	
	0.058316552	Mean
	0.089593196	ST Dev



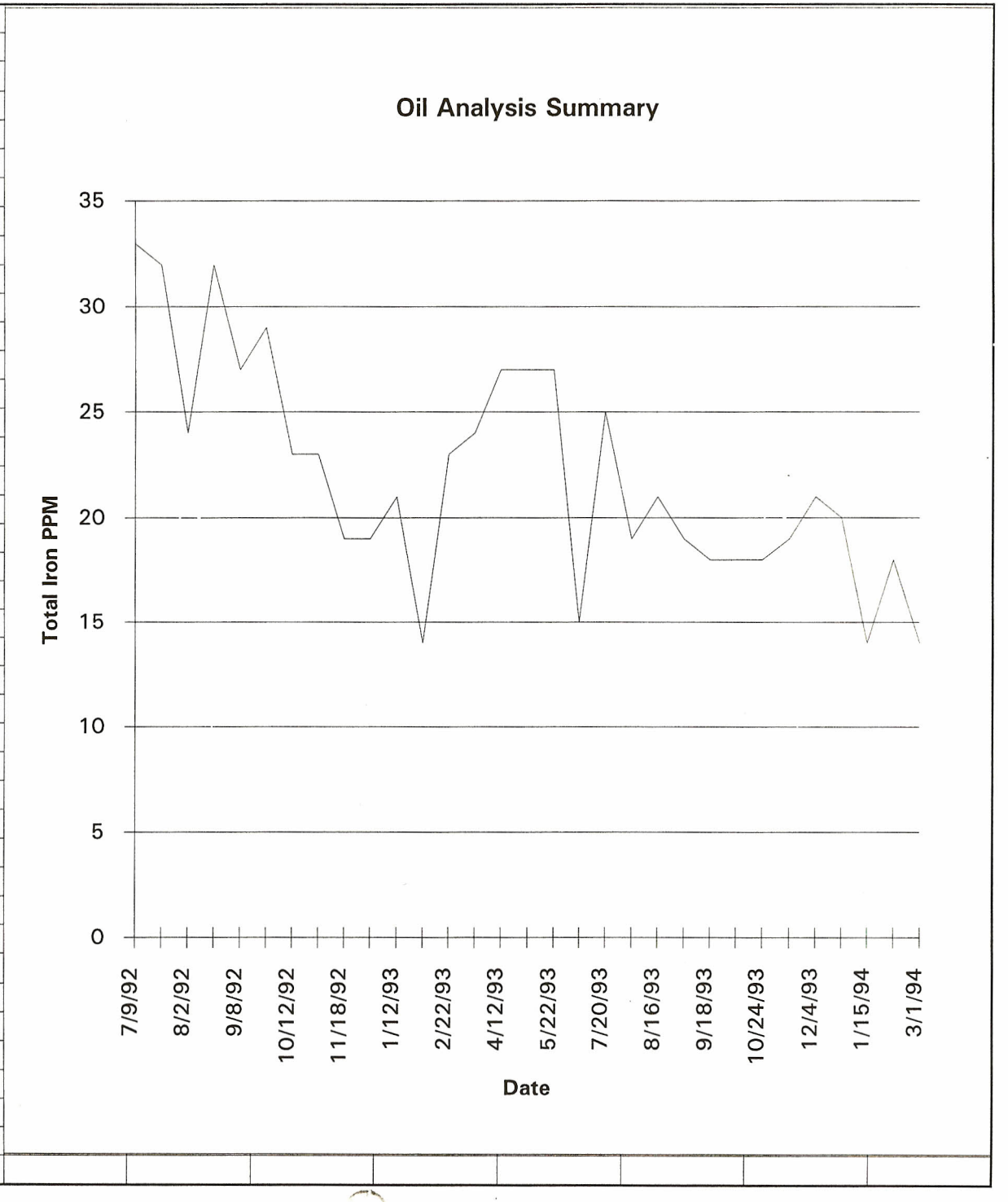
Unit # 13870 CAT 785 Haul Truck Date:	Iron	
7/21/92	95	
8/10/92	34	
8/24/92	7	
9/28/92	41	
10/29/92	50	
11/18/92	30	
12/8/92	24	
1/8/93	29	
1/25/93	21	
2/8/93	85	
	24	
3/5/93	27	
3/30/93	31	
4/17/93	32	
5/15/93	36	
6/4/93	30	
7/7/93	32	
8/11/93	33	
8/22/93	27	
9/18/93	40	
10/7/93	32	
10/28/93	26	
11/14/93	28	
11/23/93	18	
12/11/93	26	
1/1/94	24	
1/20/94	19	
2/5/94	14	
	32.6785714	Mean
	18.2960299	ST Dev



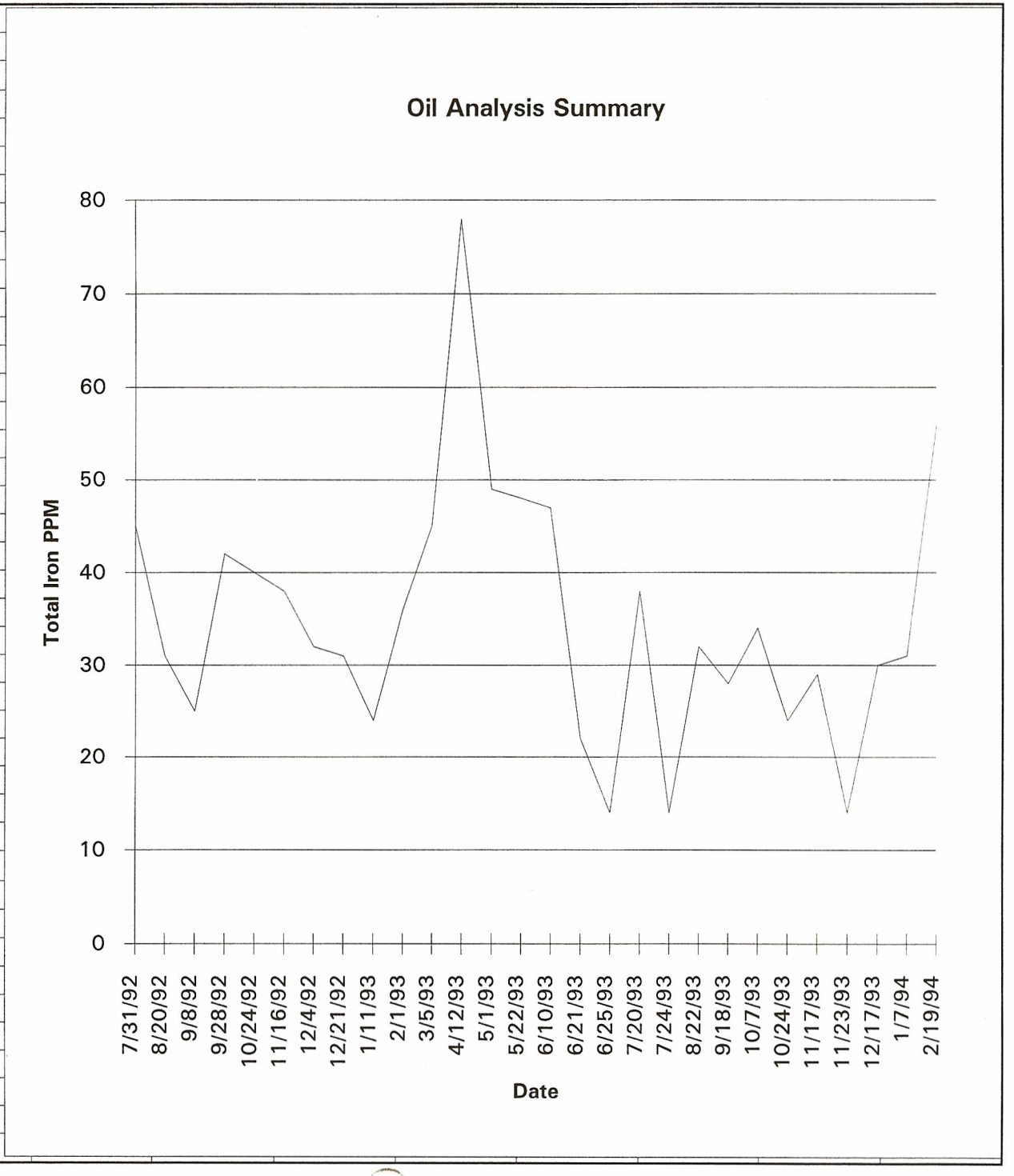
Unit # 13880 CAT 785 Haul Truck Date:	Iron:	
	45	
8/4/94	30	
8/24/92	24	
9/14/92	29	
9/28/92	26	
10/24/92	44	
11/16/92	37	
12/4/92	38	
12/28/92	31	
2/11/93	40	
3/5/93	26	
3/26/93	41	
4/12/93	34	
5/1/93	33	
5/27/93	36	
6/25/93	41	
7/28/93	51	
8/13/93	30	
9/18/93	36	
10/12/93	28	
10/28/93	20	
11/17/93	23	
11/23/93	15	
12/17/93	16	
1/15/94	19	
2/12/94	26	
	31.5	Mean
	9.2444578	ST Dev



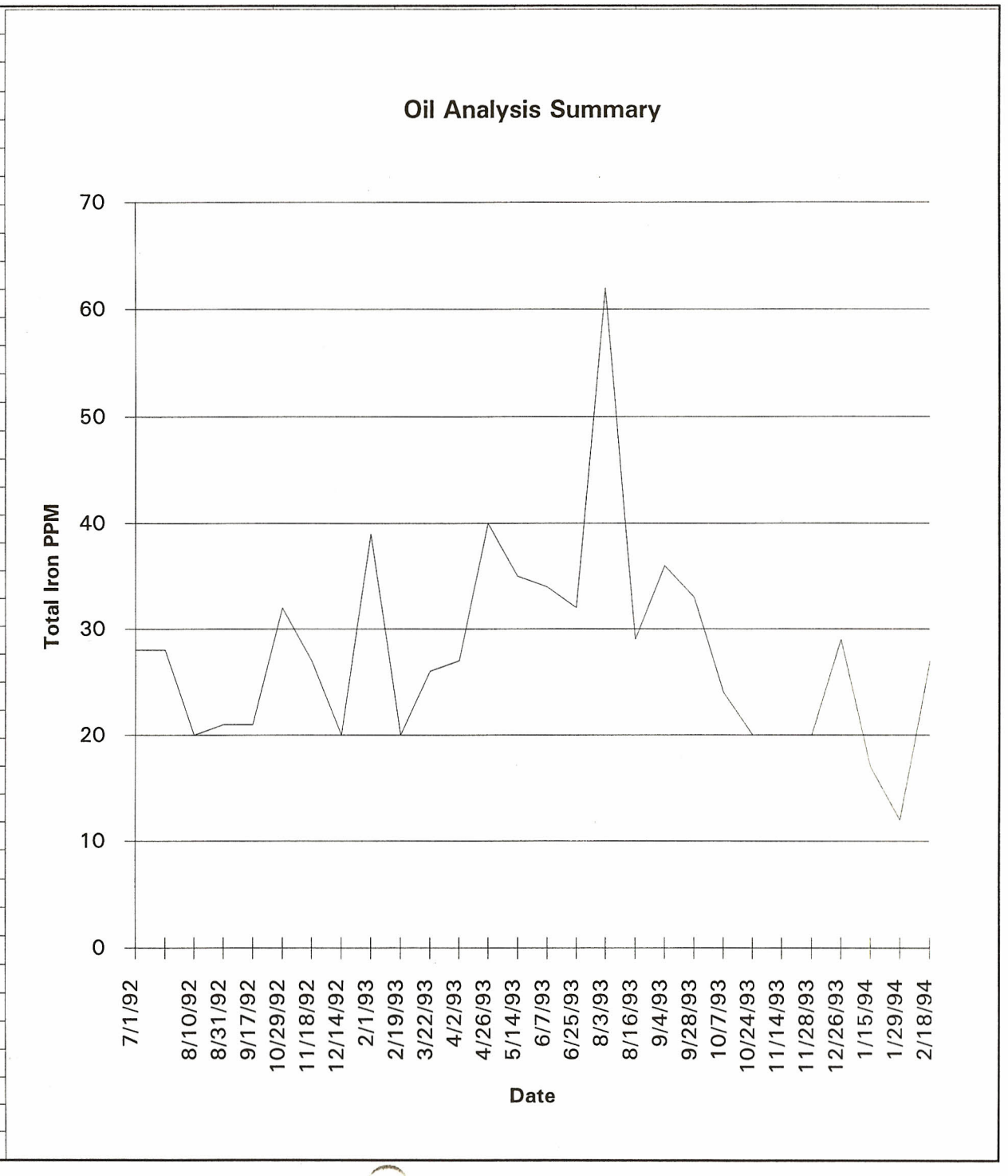
Unit # 13890 CAT 785 Haul Truck Date:	Iron	
7/9/92	33	
7/9/92	32	
8/2/92	24	
8/24/92	32	
9/8/92	27	
10/3/92	29	
10/12/92	23	
9-Nov	23	
11/18/92	19	
12/21/92	19	
1/12/93	21	
2/1/93	14	
2/22/93	23	
3/17/93	24	
4/12/93	27	
4/29/93	27	
5/22/93	27	
7/1/93	15	
7/20/93	25	
8/11/93	19	
8/16/93	21	
8/27/93	19	
9/18/93	18	
10/3/93	18	
10/24/93	18	
11/18/93	19	
12/4/93	21	
12/29/93	20	
1/15/94	14	
2/10/94	18	
3/1/94	14	
	21.2142857	Mean
	4.73252844	ST Dev



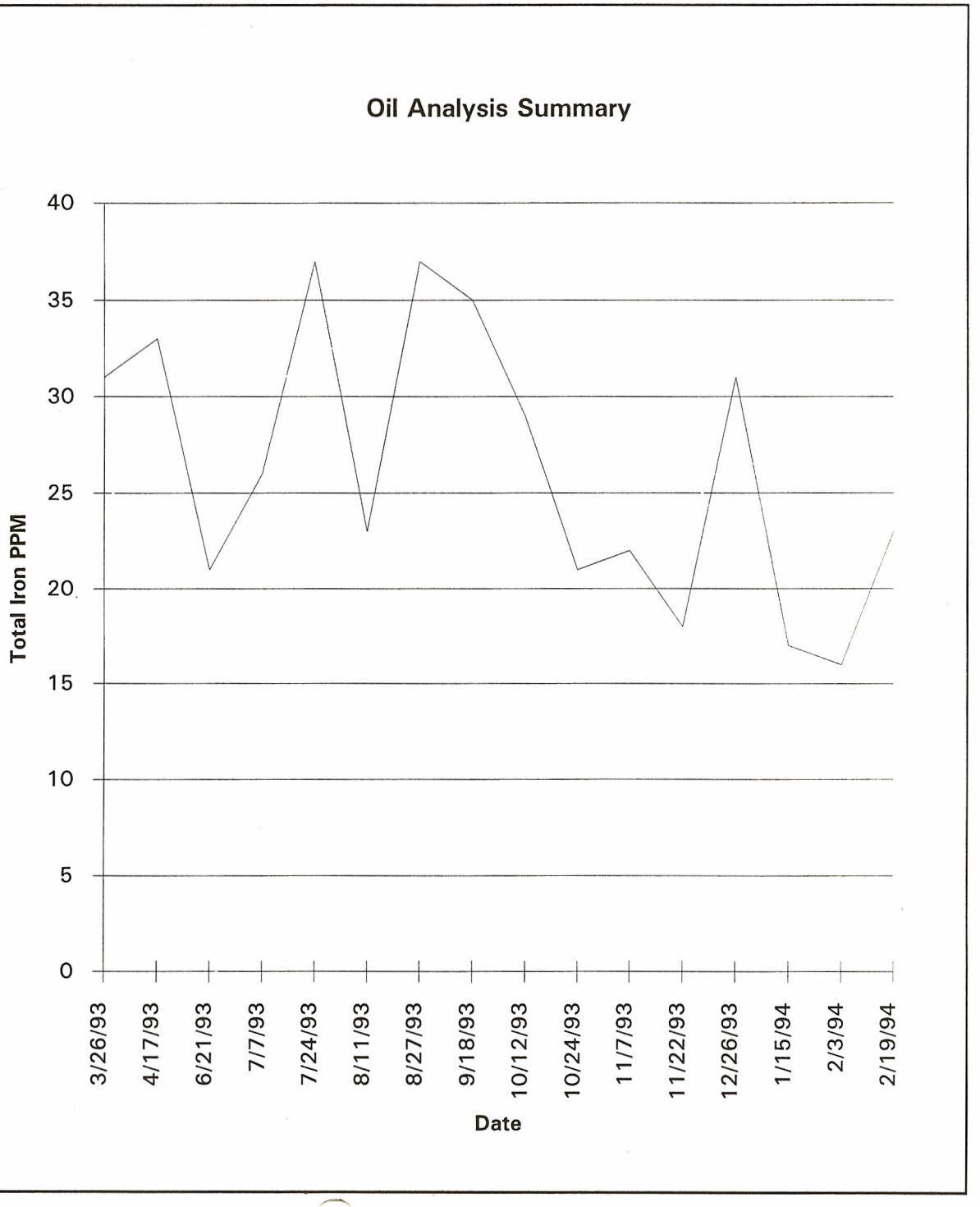
Unit # 13900 CAT 785 Haul Truck Date:	Iron:	
7/31/92	45	
8/20/92	31	
9/8/92	25	
9/28/92	42	
10/24/92	40	
11/16/92	38	
12/4/92	32	
12/21/92	31	
1/11/93	24	
2/1/93	36	
3/5/93	45	
4/12/93	78	
5/1/93	49	
5/22/93	48	
6/10/93	47	
6/21/93	22	
6/25/93	14	
7/20/93	38	
7/24/93	14	
8/22/93	32	
9/18/93	28	
10/7/93	34	
10/24/93	24	
11/17/93	29	
11/23/93	14	
12/17/93	30	
1/7/94	31	
2/19/94	56	
	34.8928571	Mean
	13.7472941	ST Dev



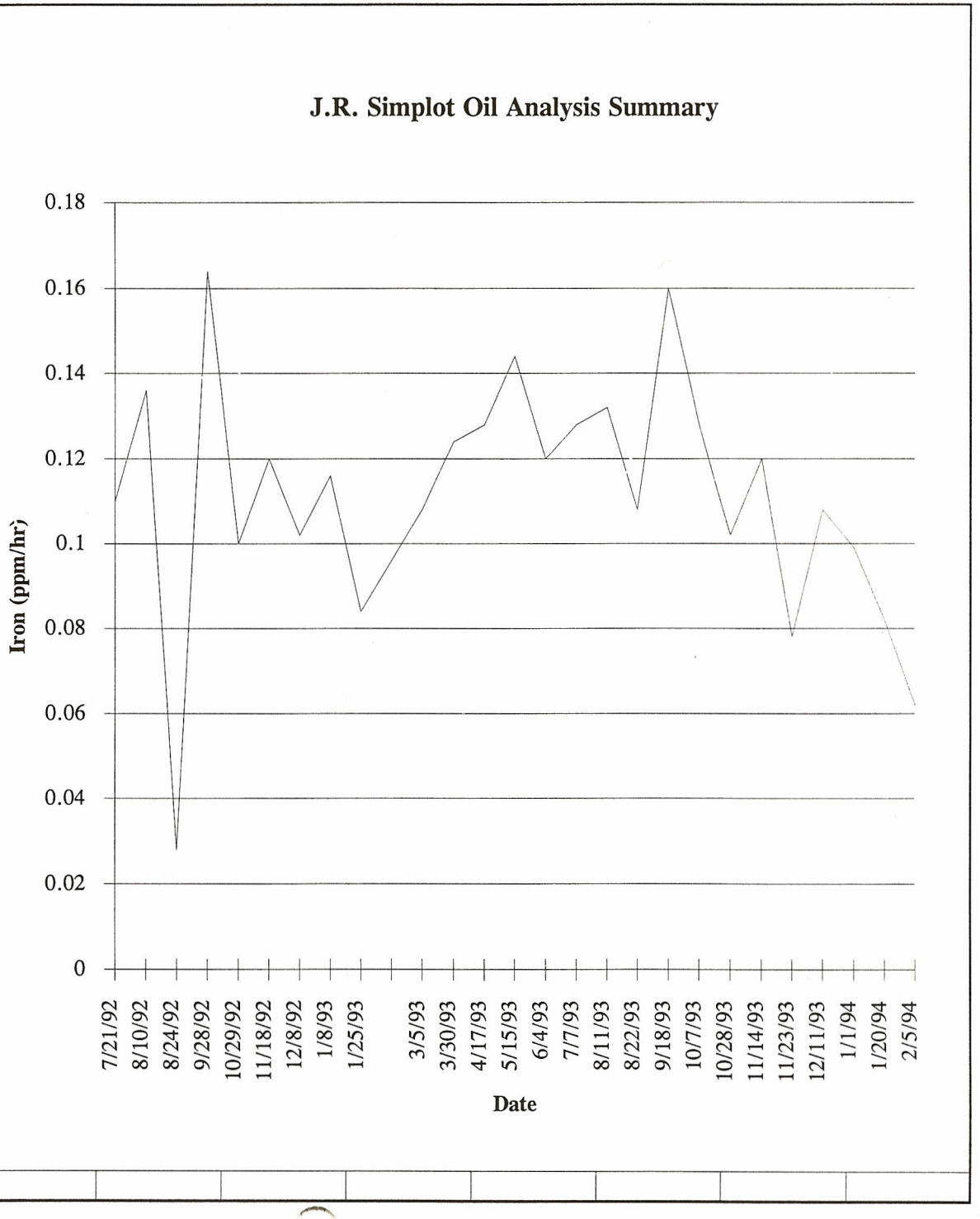
Unit # 13910 CAT 785 Haul Truck Date:	Iron:	
7/1/92	28	
	28	
8/10/92	20	
8/31/92	21	
9/17/92	21	
10/29/92	32	
11/18/92	27	
12/14/92	20	
2/1/93	39	
2/19/93	20	
3/22/93	26	
4/2/93	27	
4/26/93	40	
5/14/93	35	
6/7/93	34	
6/25/93	32	
8/3/93	62	
8/16/93	29	
9/4/93	36	
9/28/93	33	
10/7/93	24	
10/24/93	20	
11/14/93	20	
11/28/93	20	
12/26/93	29	
1/15/94	17	
1/29/94	12	
2/18/94	27	
	27.8214286	Mean
	9.64193607	ST Dev



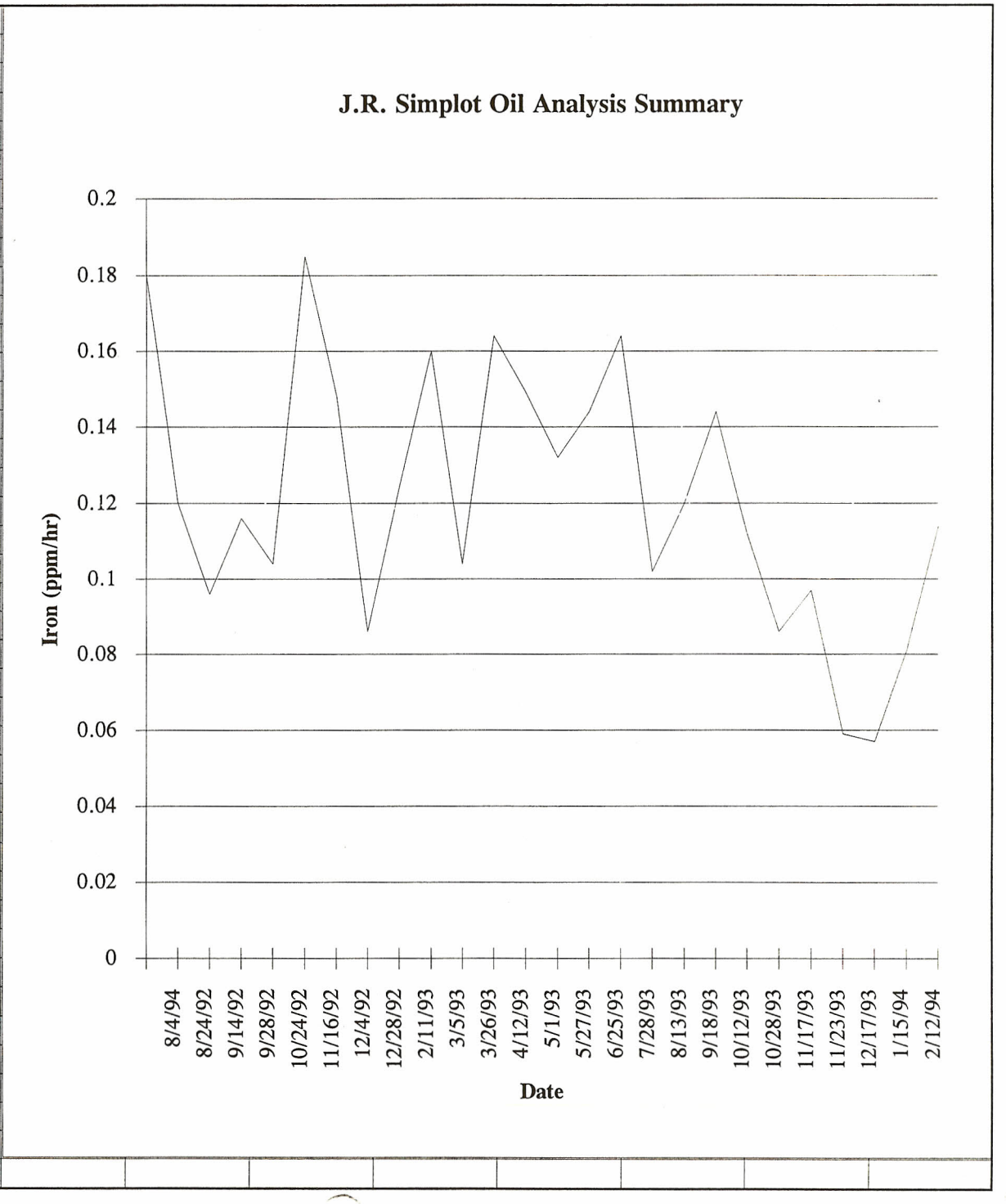
Unit # 13920 CAT 785 Haul Truck Date:	Iron:	
3/26/93	31	
4/17/93	33	
6/21/93	21	
7/7/93	26	
7/24/93	37	
8/11/93	23	
8/27/93	37	
9/18/93	35	
10/12/93	29	
10/24/93	21	
11/7/93	22	
11/22/93	18	
12/26/93	31	
1/15/94	17	
2/3/94	16	
2/19/94	23	
	25.2730551	Mean
	7.97888864	ST Dev



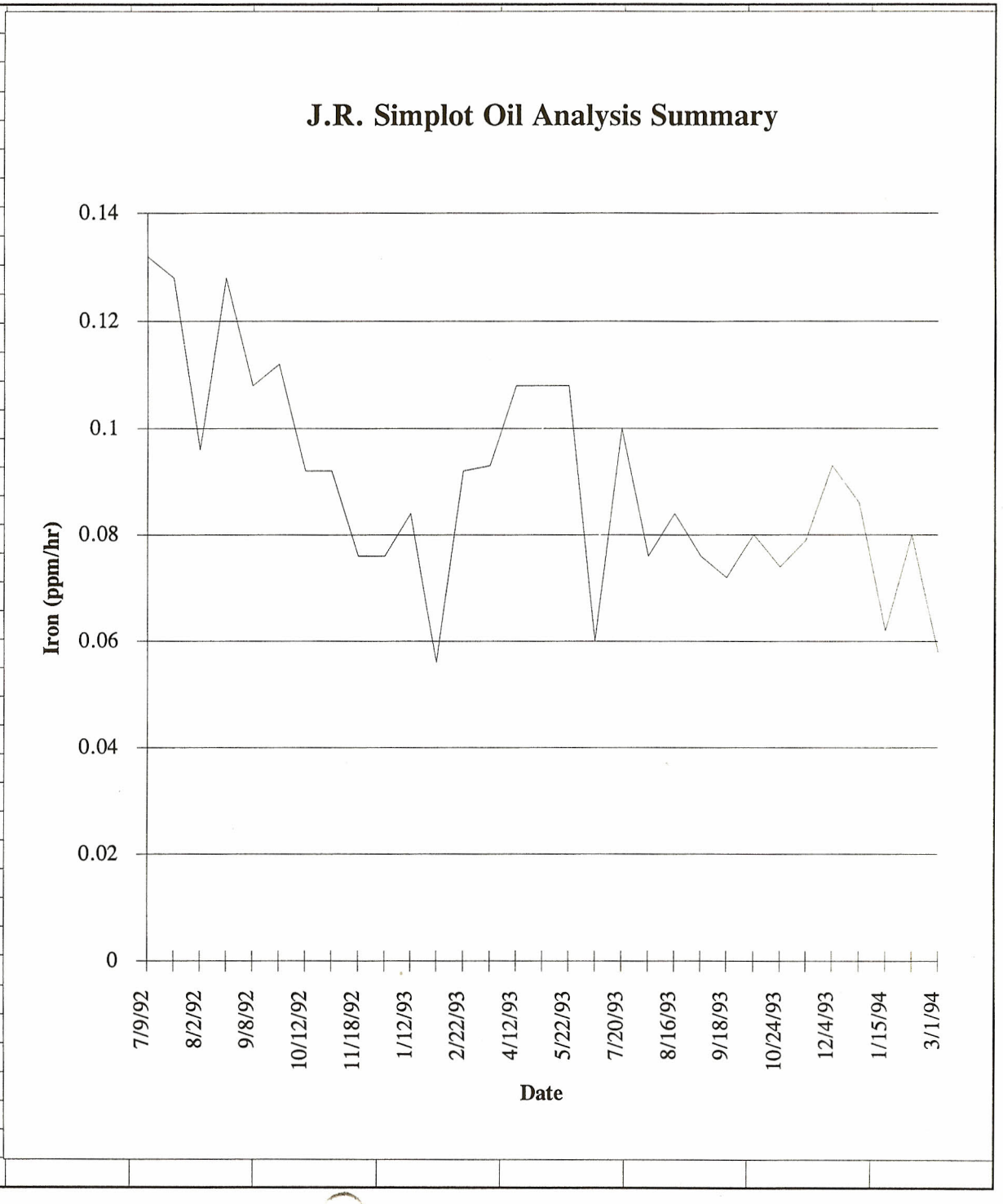
Unit # 13870 CAT 785 Haul Truck Date:	Iron (ppm/hr)	
7/21/92	0.11	
8/10/92	0.136	
8/24/92	0.028	
9/28/92	0.164	
10/29/92	0.1	
11/18/92	0.12	
12/8/92	0.102	
1/8/93	0.116	
1/25/93	0.084	
	0.096	
3/5/93	0.108	
3/30/93	0.124	
4/17/93	0.128	
5/15/93	0.144	
6/4/93	0.12	
7/7/93	0.128	
8/11/93	0.132	
8/22/93	0.108	
9/18/93	0.16	
10/7/93	0.128	
10/28/93	0.102	
11/14/93	0.12	
11/23/93	0.078	
12/11/93	0.108	
1/1/94	0.099	
1/20/94	0.082	
2/5/94	0.062	
	0.11062963	Mean
	0.028618375	ST Dev



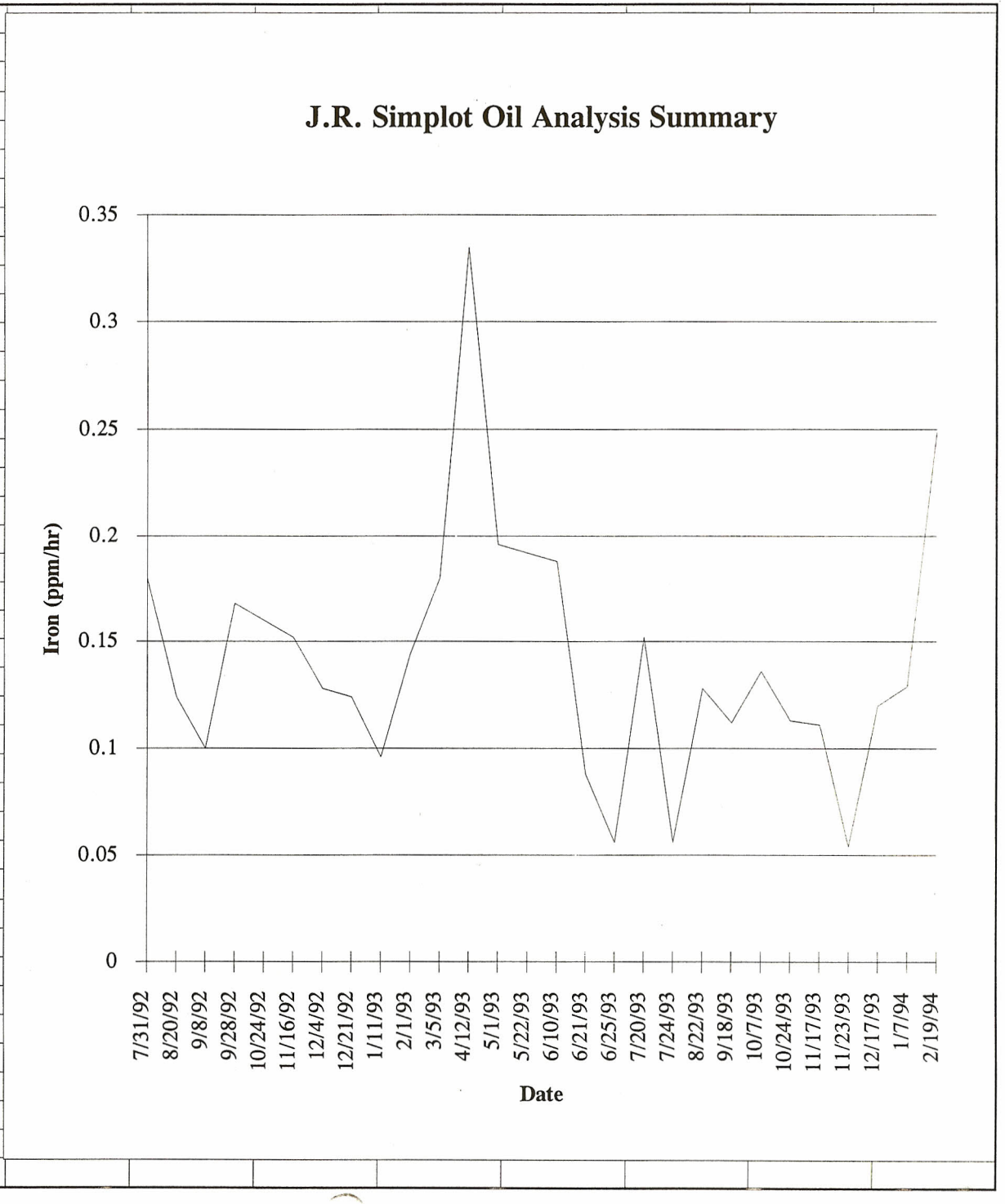
Unit # 13880 CAT 785 Haul Truck Date:	Iron (ppm/hr)	
	0.18	
8/4/94	0.12	
8/24/92	0.096	
9/14/92	0.116	
9/28/92	0.104	
10/24/92	0.185	
11/16/92	0.148	
12/4/92	0.086	
12/28/92	0.124	
2/11/93	0.16	
3/5/93	0.104	
3/26/93	0.164	
4/12/93	0.149	
5/1/93	0.132	
5/27/93	0.144	
6/25/93	0.164	
7/28/93	0.102	
8/13/93	0.12	
9/18/93	0.144	
10/12/93	0.112	
10/28/93	0.086	
11/17/93	0.097	
11/23/93	0.059	
12/17/93	0.057	
1/15/94	0.081	
2/12/94	0.114	
	0.121076923	Mean
	0.034515994	ST Dev



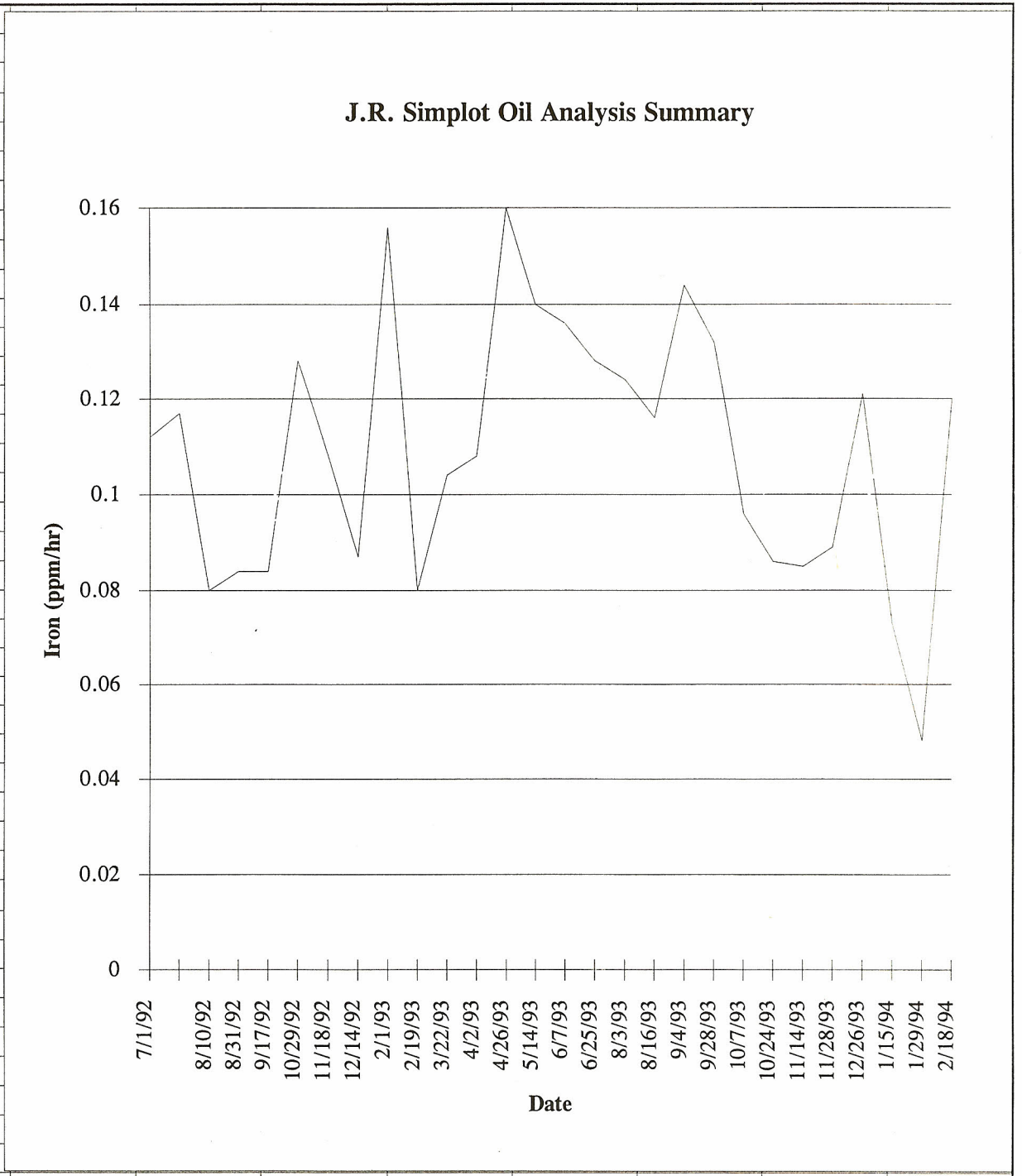
Unit # 13890 CAT 785 Haul Truck Date:	Iron (ppm/hr)	
7/9/92	0.132	
7/23/92	0.128	
8/2/92	0.096	
8/24/92	0.128	
9/8/92	0.108	
10/3/92	0.112	
10/12/92	0.092	
9-Nov	0.092	
11/18/92	0.076	
12/21/92	0.076	
1/12/93	0.084	
2/1/93	0.056	
2/22/93	0.092	
3/17/93	0.093	
4/12/93	0.108	
4/29/93	0.108	
5/22/93	0.108	
7/1/93	0.06	
7/20/93	0.1	
8/11/93	0.076	
8/16/93	0.084	
8/27/93	0.076	
9/18/93	0.072	
10/3/93	0.08	
10/24/93	0.074	
11/18/93	0.079	
12/4/93	0.093	
12/29/93	0.086	
1/15/94	0.062	
2/10/94	0.08	
3/1/94	0.058	
	0.086178571	Mean
	0.017828511	ST Dev



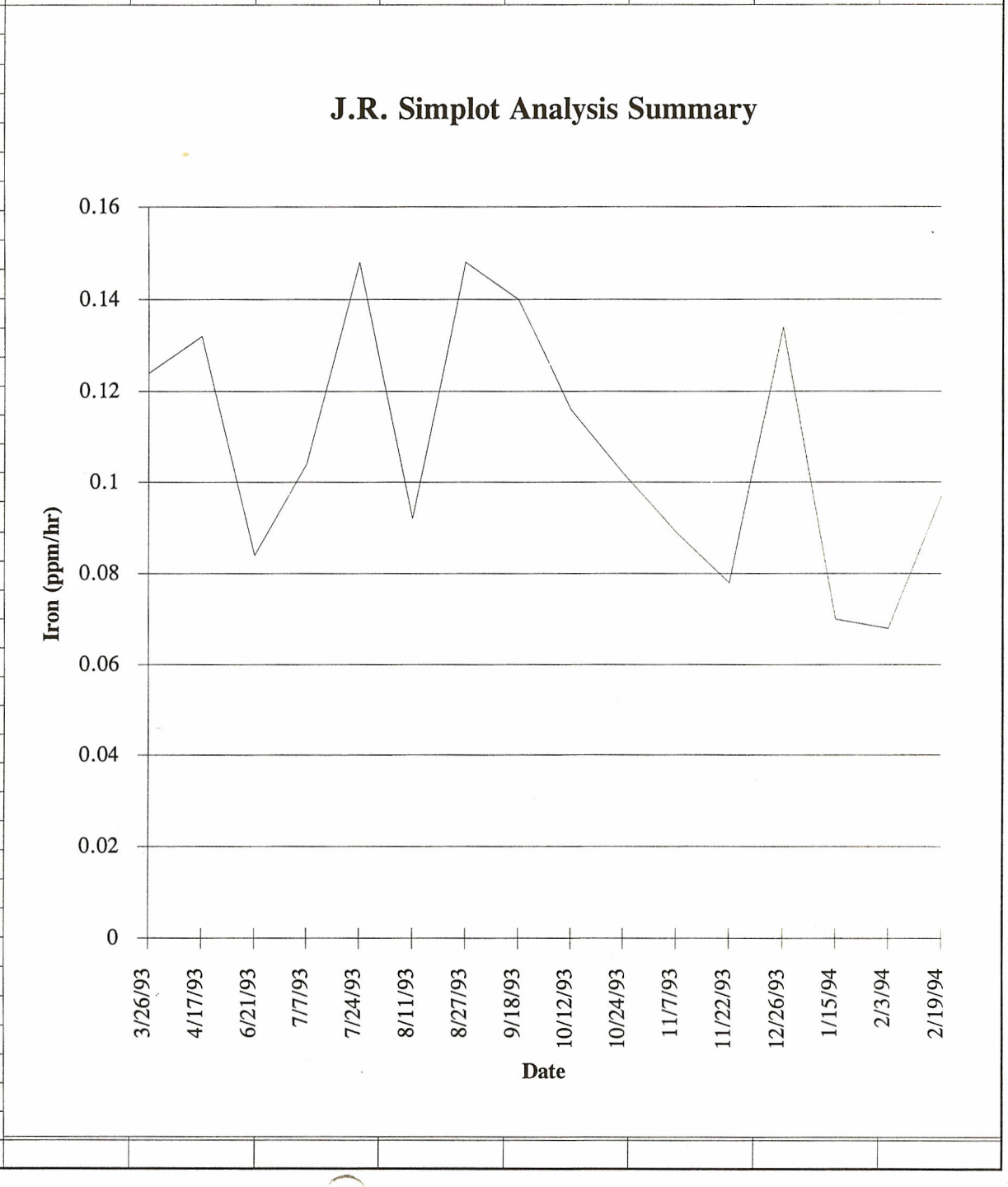
Unit # 13900 CAT 785 Haul Truck Date:	Iron (ppm/hr)	
7/31/92	0.18	
8/20/92	0.124	
9/8/92	0.1	
9/28/92	0.168	
10/24/92	0.16	
11/16/92	0.152	
12/4/92	0.128	
12/21/92	0.124	
1/11/93	0.096	
2/1/93	0.144	
3/5/93	0.18	
4/12/93	0.335	
5/1/93	0.196	
5/22/93	0.192	
6/10/93	0.188	
6/21/93	0.088	
6/25/93	0.056	
7/20/93	0.152	
7/24/93	0.056	
8/22/93	0.128	
9/18/93	0.112	
10/7/93	0.136	
10/24/93	0.113	
11/17/93	0.111	
11/23/93	0.054	
12/17/93	0.12	
1/7/94	0.129	
2/19/94	0.249	
	0.141821429	Mean
	0.059030471	ST Dev



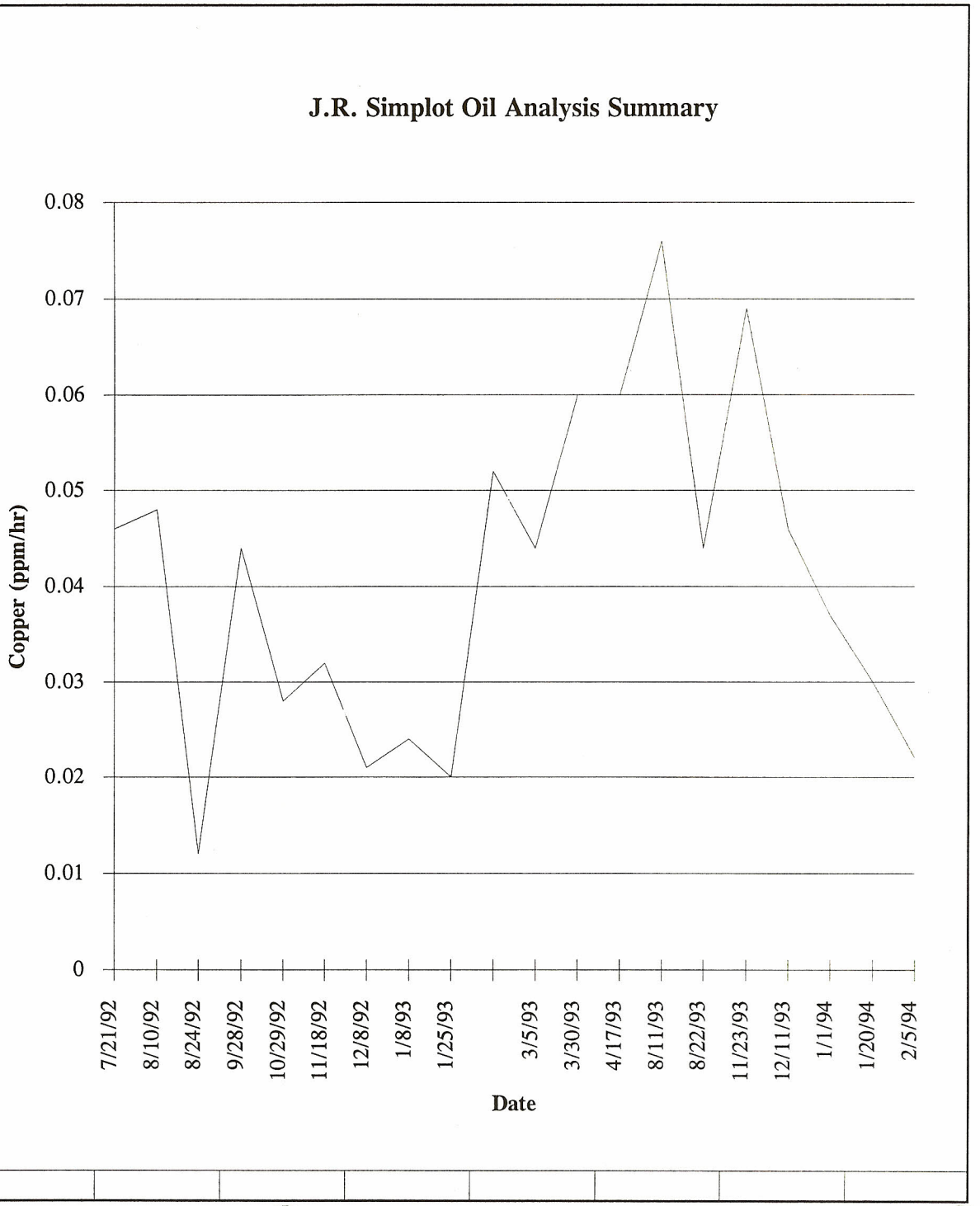
Unit # 13910 CAT 785 Haul Truck Date:	Iron:	
7/1/92	0.112	
	0.117	
8/10/92	0.08	
8/31/92	0.084	
9/17/92	0.084	
10/29/92	0.128	
11/18/92	0.108	
12/14/92	0.087	
2/1/93	0.156	
2/19/93	0.08	
3/22/93	0.104	
4/2/93	0.108	
4/26/93	0.16	
5/14/93	0.14	
6/7/93	0.136	
6/25/93	0.128	
8/3/93	0.124	
8/16/93	0.116	
9/4/93	0.144	
9/28/93	0.132	
10/7/93	0.096	
10/24/93	0.086	
11/14/93	0.085	
11/28/93	0.089	
12/26/93	0.121	
1/15/94	0.073	
1/29/94	0.048	
2/18/94	0.12	
	0.108785714	Mean
	0.027025855	ST Dev



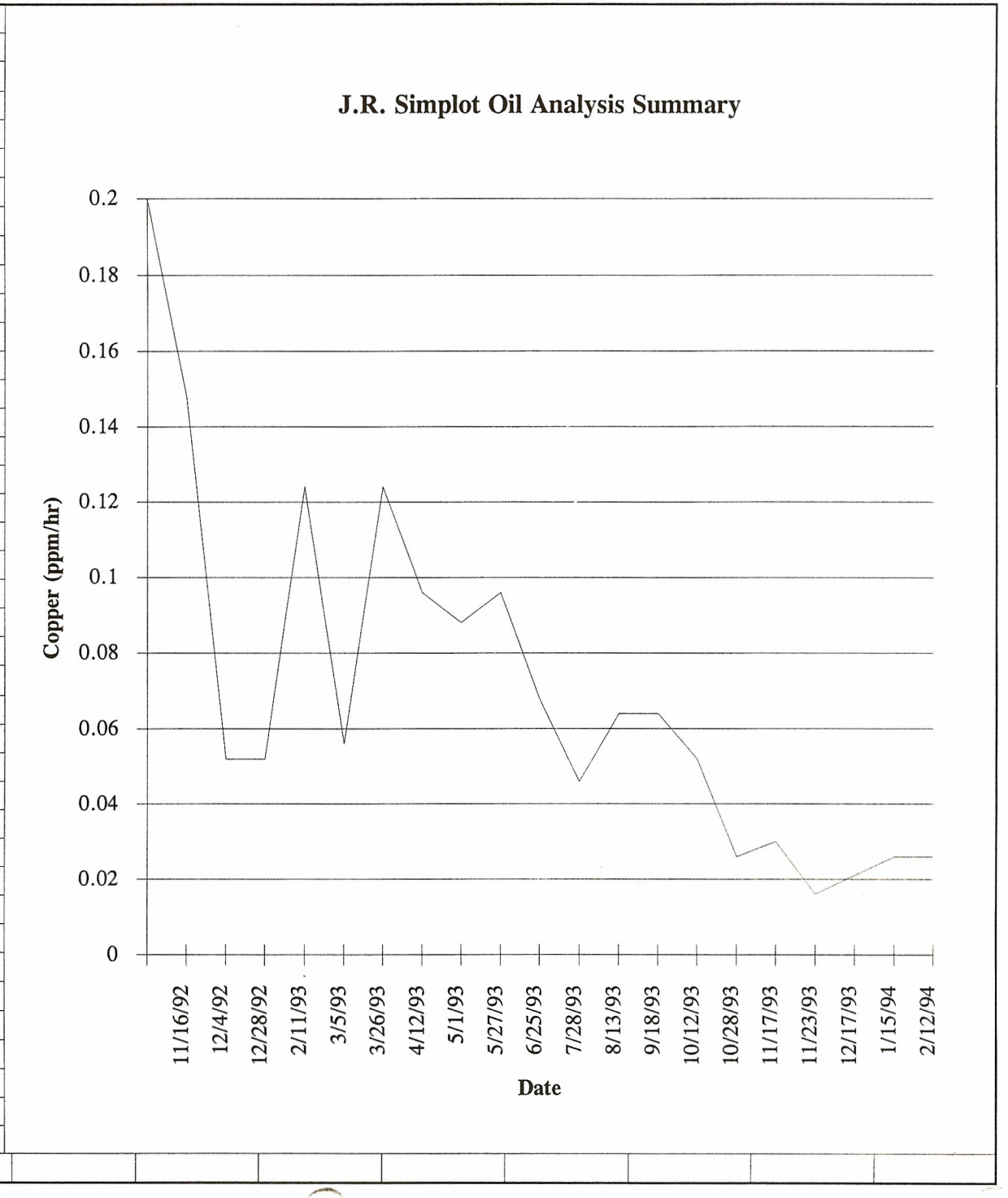
Unit # 13920 CAT 785 Haul Truck Date:	Iron:	
3/26/93	0.124	
4/17/93	0.132	
6/21/93	0.084	
7/7/93	0.104	
7/24/93	0.148	
8/11/93	0.092	
8/27/93	0.148	
9/18/93	0.14	
10/12/93	0.116	
10/24/93	0.102	
11/7/93	0.089	
11/22/93	0.078	
12/26/93	0.134	
1/15/94	0.07	
2/3/94	0.068	
2/19/94	0.097	
	0.103119168	Mean
	0.032842264	ST Dev



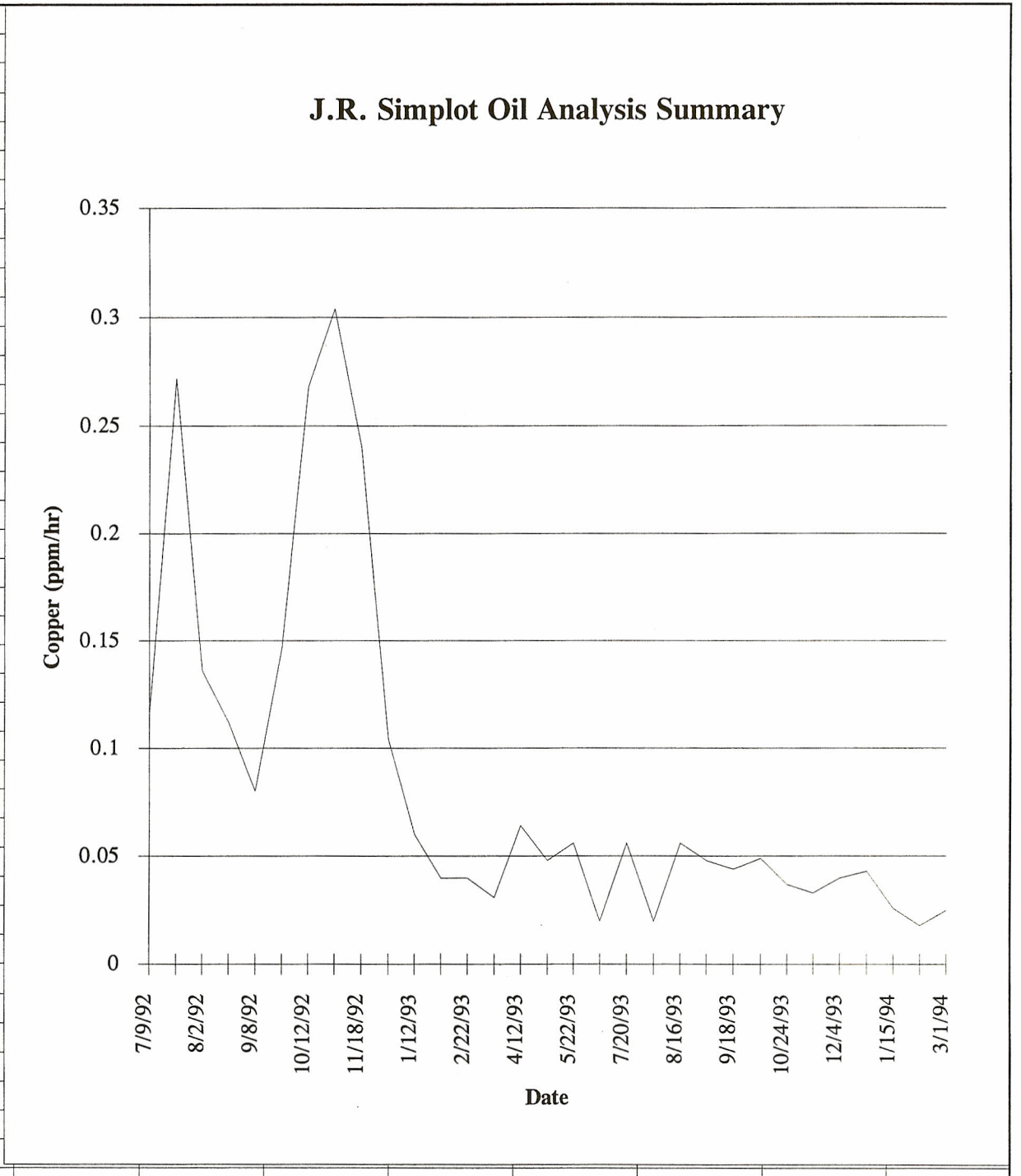
Unit # 13870 CAT 785 Haul Truck Date:	Copper (ppm/hr)	
7/21/92	0.046	
8/10/92	0.048	
8/24/92	0.012	
9/28/92	0.044	
10/29/92	0.028	
11/18/92	0.032	
12/8/92	0.021	
1/8/93	0.024	
1/25/93	0.02	
	0.052	
3/5/93	0.044	
3/30/93	0.06	
4/17/93	0.06	
8/11/93	0.076	
8/22/93	0.044	
11/23/93	0.069	
12/11/93	0.046	
1/1/94	0.037	
1/20/94	0.03	
2/5/94	0.022	
	0.04075	Mean
	0.01731405	ST Dev



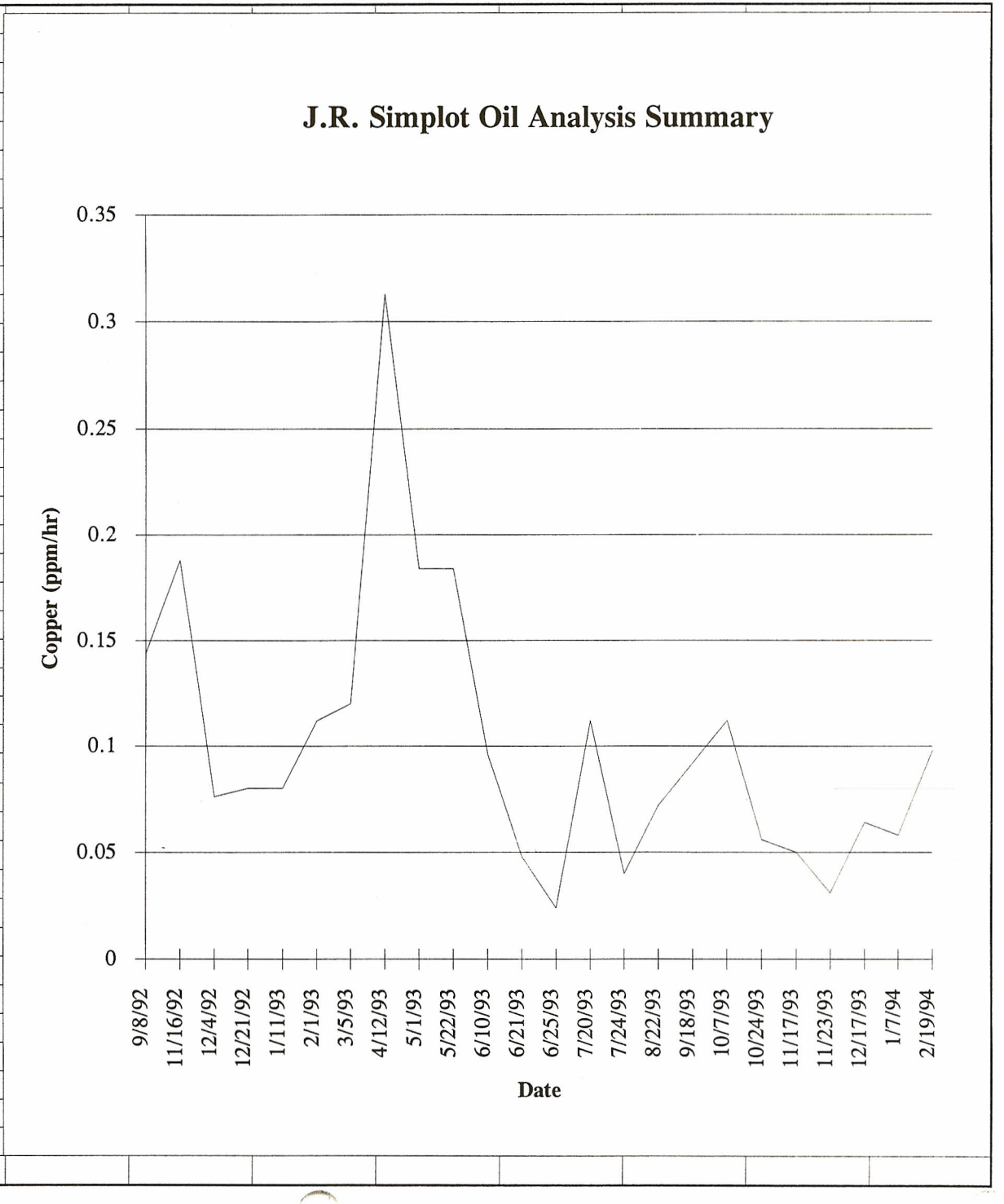
Unit # 13880 CAT 785 Haul Truck Date:	Copper (ppm/hr)	
	0.2	
11/16/92	0.148	
12/4/92	0.052	
12/28/92	0.052	
2/11/93	0.124	
3/5/93	0.056	
3/26/93	0.124	
4/12/93	0.096	
5/1/93	0.088	
5/27/93	0.096	
6/25/93	0.068	
7/28/93	0.046	
8/13/93	0.064	
9/18/93	0.064	
10/12/93	0.052	
10/28/93	0.026	
11/17/93	0.03	
11/23/93	0.016	
12/17/93	0.021	
1/15/94	0.026	
2/12/94	0.026	
	0.070238095	Mean
	0.047453034	ST Dev



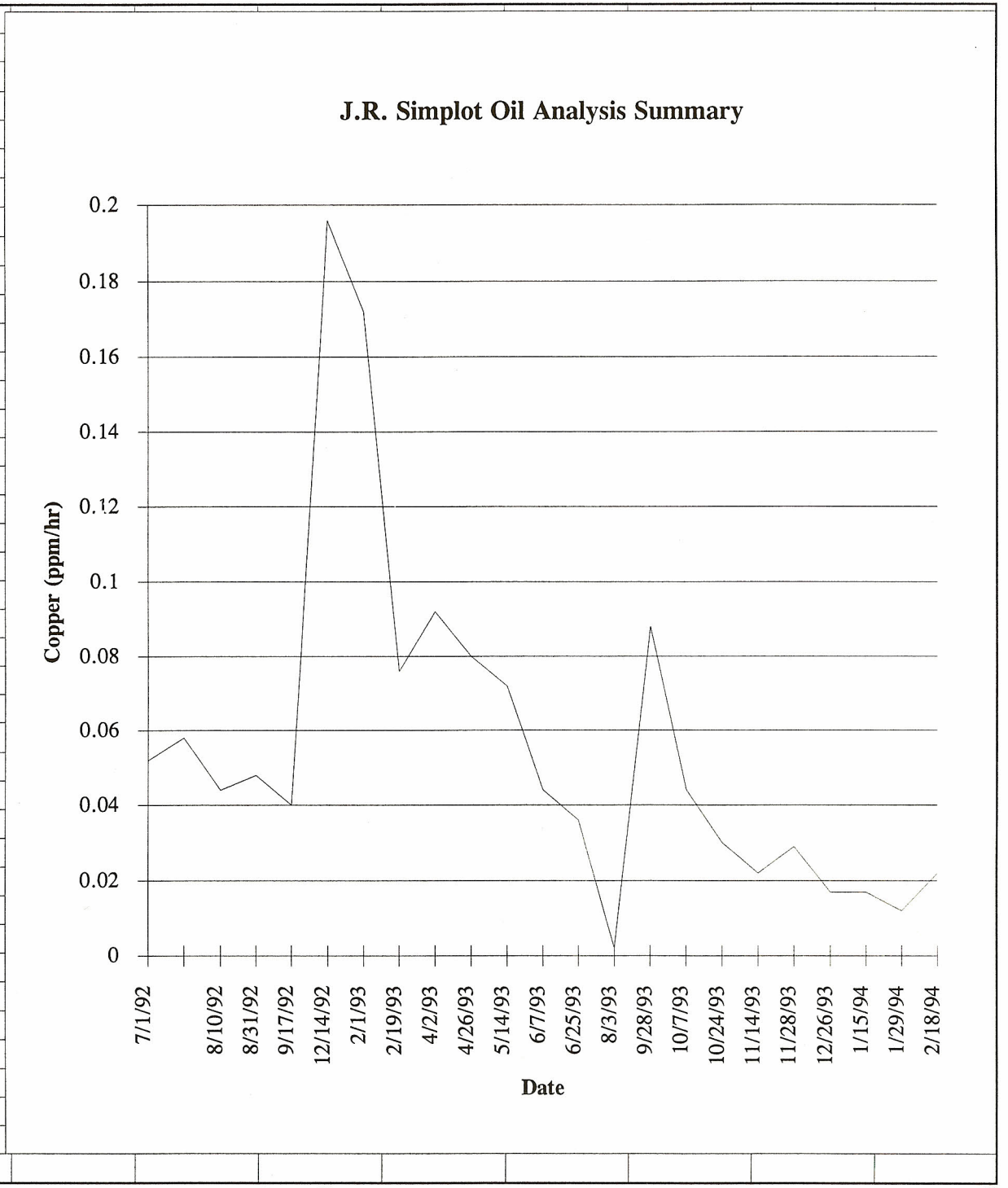
Unit # 13890 CAT 785 Haul Truck Date:	Copper (ppm/hr)	
7/9/92	0.116	
7/23/92	0.272	
8/2/92	0.136	
8/24/92	0.112	
9/8/92	0.08	
10/3/92	0.147	
10/12/92	0.268	
11/9/92	0.304	
11/18/92	0.24	
12/21/92	0.104	
1/12/93	0.06	
2/1/93	0.04	
2/22/93	0.04	
3/17/93	0.031	
4/12/93	0.064	
4/29/93	0.048	
5/22/93	0.056	
7/1/93	0.02	
7/20/93	0.056	
8/11/93	0.02	
8/16/93	0.056	
8/27/93	0.048	
9/18/93	0.044	
10/3/93	0.049	
10/24/93	0.037	
11/18/93	0.033	
12/4/93	0.04	
12/29/93	0.043	
1/15/94	0.026	
2/10/94	0.018	
3/1/94	0.025	
	0.075321429	Mean
	0.075252195	ST Dev



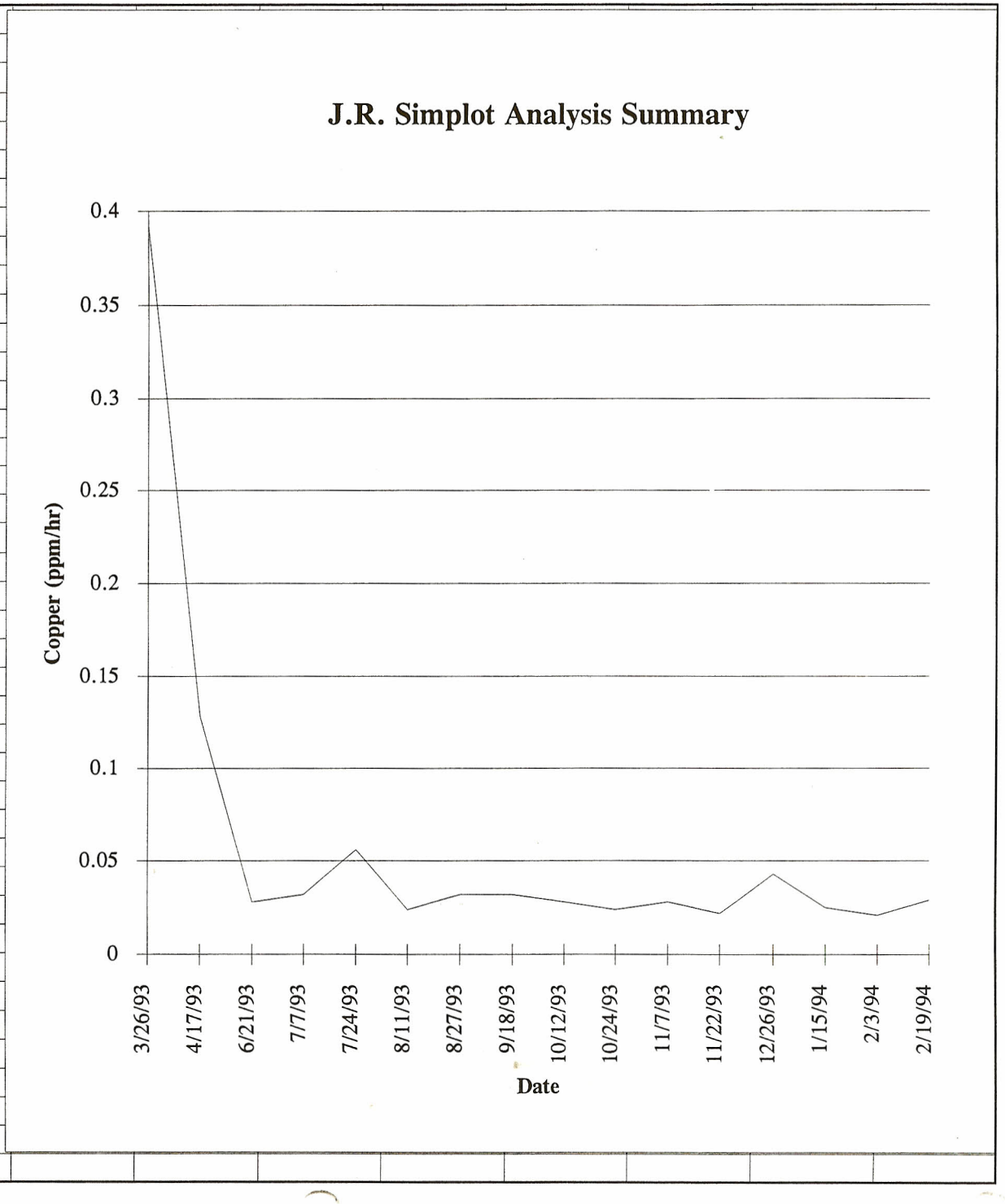
Unit # 13900 CAT 785 Haul Truck Date:	Copper (ppm/hr)	
9/8/92	0.144	
11/16/92	0.188	
12/4/92	0.076	
12/21/92	0.08	
1/11/93	0.08	
2/1/93	0.112	
3/5/93	0.12	
4/12/93	0.313	
5/1/93	0.184	
5/22/93	0.184	
6/10/93	0.096	
6/21/93	0.048	
6/25/93	0.024	
7/20/93	0.112	
7/24/93	0.04	
8/22/93	0.072	
9/18/93	0.092	
10/7/93	0.112	
10/24/93	0.056	
11/17/93	0.05	
11/23/93	0.031	
12/17/93	0.064	
1/7/94	0.058	
2/19/94	0.098	
	0.101416667	Mean
	0.064782524	ST Dev



Unit # 13910 CAT 785 Haul Truck Date:	Copper (ppm/hr)	
7/1/92	0.052	
	0.058	
8/10/92	0.044	
8/31/92	0.048	
9/17/92	0.04	
12/14/92	0.196	
2/1/93	0.172	
2/19/93	0.076	
4/2/93	0.092	
4/26/93	0.08	
5/14/93	0.072	
6/7/93	0.044	
6/25/93	0.036	
8/3/93	0.002	
9/28/93	0.088	
10/7/93	0.044	
10/24/93	0.03	
11/14/93	0.022	
11/28/93	0.029	
12/26/93	0.017	
1/15/94	0.017	
1/29/94	0.012	
2/18/94	0.022	
	0.056217391	Mean
	0.047381389	ST Dev



Unit # 13920 CAT 785 Haul Truck Date:	Copper (ppm/hr)	
3/26/93	0.392	
4/17/93	0.128	
6/21/93	0.028	
7/7/93	0.032	
7/24/93	0.056	
8/11/93	0.024	
8/27/93	0.032	
9/18/93	0.032	
10/12/93	0.028	
10/24/93	0.024	
11/7/93	0.028	
11/22/93	0.022	
12/26/93	0.043	
1/15/94	0.025	
2/3/94	0.021	
2/19/94	0.029	
	0.058316552	Mean
	0.089593196	ST Dev



UHI TECHNICAL BULLETIN No. 401 January 1993

THE EFFECT OF FPC-1® ON LUBE OIL SOOT LEVELS

Soot in lubricating oil is largely produced by inefficient combustion of diesel fuel. It is composed of the same particles as those escaping from the exhaust stack in the form of smoke. There may be some contribution to soot from lube oil burning, but this is of minor significance.

The presence of soot in the lube oil is of importance because it is a major factor in causing abrasive engine wear. The rate of soot accumulation in the lube oil depends upon the following factors:

1) The Rate of Soot Production. This occurs during the combustion process. Soot is formed as a result of inefficient fuel combustion.

2) The Rate of Gas Blowby. Soot formed during combustion is forced past the piston rings and accumulates in the lube oil. Here the soot acts like a fine grinding powder contributing to the rate of wear inside the engine.

3) The Rate of Soot Contaminant Removal by the Oil Filter. The rate of soot removal may be influenced by soot particle size.

4) The Rate of Removal and Dilution of Soot Contaminants due to Oil Burning/Make-up.

Combustion efficiency can be improved by catalysis using FPC-1® Fuel Performance Catalyst fuel treatment. Soot particulate size and mass are reduced, as are soot blowby and accumulation in the lube oil. Research indicates that the reduction in soot particle size and mass may have a positive effect on abrasive wear.

Soot and Abrasive Wear

The contribution of soot to component wear depends upon the size of the soot particles and their relationship to the minimum oil film thickness. For the same load, a bearing of smaller contact surface area will have to rely on a thinner oil film for lubrication. Abrasive wear due to soot will be more severe. For similar bearings under similar loads, the larger the soot particle size, the more severe the abrasive wear. The same applies for all sliding surfaces.

The FPC-1® catalyst has long been known to reduce soot and solids content of the lube oil, thereby reducing abrasive wear. In more severe operations, 50% reduction in liner wear has

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been measured.

Wear Trends and Soot Levels

A review of oil analysis records generally shows the expected clear trend to reduced iron and lead profiles, and in most, but not all cases, reduced soot levels. Since the catalyst typically assists in reducing oil consumption by improved cleanliness in piston rings and grooves, it is essential to factor results for oil make-up, to obtain accurate assessment of performance.

Determination of Soot Particle Size and Influence

A study was undertaken to determine the effect of the FPC-1® catalyst on soot particle size. With the cooperation of a major mine operator and equipment dealer, 8 used engine oil samples from a FPC-1® treated site plus 8 anonymous samples (to act as controls) were obtained for comparison. All samples were from the same make engines using identical brands of diesel engine oil. The controls have come from sites not using FPC-1® fuel catalyst.

Microscopic examination of all samples in conjunction with a stage mounted objective micrometer permitted estimation of soot particle size. Refer to Tables I and II.

Table I
Average Soot Particle Size

Control Group		FPC Group	
Lab No.	Ave. Dia.(um)	Lab No.	Ave. Dia.(um)
11P448	.60	11N315	.17-.20
11P229	.42	11P544	.17-.20
11P437	.60	11K334	.17-.20
11P341	.70	11K336	.17-.20
11P537	.60	11L330	.17-.20
11P436	.42	11L314	.20-.25
11P230	.55	11M334	.17-.20
11P340	.70	11L329	.17-.20
Range	.42-.70		.17-.25
Average	.52 micron		.19 micron

Because of the small particle sizes encountered in the FPC-1® treated samples and the limited microscope power available, a more precise number than the one given was not possible.

The occurrence of larger soot particles was observed in both groups. The control group contained the largest soot particles observed.

Table II
Largest Soot Particle Size

Control Group		FPC Group	
Lab No.	Ave. Dia.(um)	Lab No.	Ave. Dia.(um)
11P448	1.7	11N315	1.0
11P229	1.4	11P544	0.8
11P437	2.1	11K334	1.4
11P341	1.4	11K336	1.4
11P537	2.1	11L330	0.8
11P436	1.4	11L314	1.4
11P230	1.7	11M334	1.0
11P340	1.0	11L329	1.7
Range	1.0-2.1		0.8-1.7
Average	1.6 micron		1.2 micron

The results of this study are consistent with the changes measured in exhaust gases and would appear to confirm the catalyst has the effect of reducing the diameter of the majority of the soot particles to approximately one-third (1/3rd). That is, the mass of the soot particles is reduced to one-twenty-seventh (1/27th). It also appears to provide the explanation for the reduced wear metals profiles observed by FPC-1® users.

A major Central Queensland coal mine has provided some recent documentation of the effect of FPC-1® on reduced engine wear.

FPC-1® was introduced into the fuel for the coal mines mobile fleet. Data from the mine's R&D laboratory in MacKay was used to construct wear profiles. These profiles confirmed substantial wear reductions in the range of 18% to 46% while the fleet operated on FPC-1® treated fuel.

Poor combustion can hamper engine lubrication

One of the major duties of a diesel engine oil is to keep lubricated parts free of deposits, but this function is often hampered by poor combustion, according to Mr Brid Walker regional manager of Queensland company Fuel Technology Pty Ltd.

For engine cleanliness, an oil's detergency/dispersancy package is called upon to remove and suspend deposits that exist. It must also prevent further deposits from forming on surfaces. These contaminants are suspended until they can be removed by the filter or at the next oil change.

Engine deposits can be caused by many factors, such as fouled injectors, overfuelling, incorrect timing, clogged air filters, overextended oil change intervals, altitude and temperature factors, engine condition and application. Whatever the reason, the result is the same — the oil is called on to work harder.

However, assuming good maintenance and operating practices exist, the fuel itself may not burn properly. With today's diesel fuels it's a greater problem. The slower burning fractions of diesel are associated with black smoke and deposit formations.

Deposits tend to form on combustion surfaces such as cylinder heads, valves, piston crowns, top lands, ring grooves, injectors, etc. This promotes a condition which, in itself (because of reduced cylinder compression, poor oil control, poor fuel spray patterns) causes very poor combustion.

While the oil is trying to remove deposits as they form in ring grooves etc, it is also being rapidly taxed by soot reaching it through exhaust blow-by. Soot is damaging. It's an abrasive just like valve grinding paste, only a bit slower. This reduces the oils cleaning ability, which allows deposits to build up faster, increasing blow-by and soot. Higher levels of maintenance are required and operating efficiency and engine life are reduced quite measurably. According to Mr Walker, "lubrication is a bandaid remedy to a combustion problem".

A major Central Queensland coal mine has provided some recent insight into this. In conjunction with Fuel Technology, a combustion catalyst was introduced into the fuel for the mobile fleet. Mr Walker used data from the mine's research and development laboratory in Mackay to construct wear profiles. Substantial wear reductions were noted (in the range 18-46 per cent). Mr Walker said: "With less soot being produced and reaching the lube oil, abrasive wear can be reduced dramatically. The oil can then cope better with keeping ring grooves cleaner and reducing blow-by.

This was confirmed in the fleet of 12 Cummins-powered coal haulers, which showed an average 58 per cent reduction in oil consumption.

Inspection of a Cat 3412 engine from a Cat 992C loader bore testimony to the benefits of an efficient burn. The engine displayed a complete absence of sludge, with valve covers and sump pan in very clean condition. Cylinder heads, piston crowns exhaust manifolds and turbochargers were coated with a light fluffy layer of soot, which easily wiped off to expose bare metal. Valve part numbers could be clearly read.

Injectors were clean and free of deposits. Inlet and exhaust ports were totally free of any hard deposits. Slight inlet valve stem deposits were noted and these showed signs of erosion. Piston top land deposits were moderate, while rings were free in their grooves and skirts exhibited no varnish.

Overall, the description is one of a very clean engine. But, considering that the engine was overhauled at a programmed change-out, with a total of almost 17,000 hours (original and untouched), its condition can only be described as exceptional. It had burnt catalyst treated fuel for approximately 2400 hours.

The mine has noticed a reduced incidence of carbon related failures during the period of catalyst use. The recent heavy rains in Central Queensland clearly quantified the cost of lost production.

Maintenance of mine equipment saves downtime

The biggest costs to mine production occur when equipment is not being worked. That's usually during strikes, wet, weather and equipment downtime. The latter is directly in the hands of the mines maintenance people and they need to quantify that cost in terms of dollars per unit per hour.

Consider a large open cut coal mine with daily production valued at $1,000,000 and a 10 piece fleet of coal haulers able to work 20 hours per day. If downtime in these units causes production bottlenecks, it is costing the mine $5000 per truck per hour! If a truck drops a valve and is down for 4½ shifts, that costs the mine $150,000. An engine swap perhaps $350,000-$400,000.

Brid Walker of Fuel Technology, Brisbane, has found that a great deal of equipment downtime is due to combustion problems.

While distillate is widely recognised as the major running cost in diesel fleet operations, it is also the most neglected. Walker says that to the majority of maintenance people, diesel fuel is a "black box item". Yet these same people recognise two facts:

- Diesel fuel has deteriorated in quality over the years.
- The performance of diesel engines has increased substantially.

So what happens when diesel fuel specifications limit the performance of engines?

The evidence of decreased combustion efficiency has been staring us in the face for years.

These days, there is a high incidence of increased — deposit formation, injection fouling, ring sticking, bore polish, high oil consumption, high oil soot, black smoke and valve failures.

There is also decreased fuel efficiency, and engine life.

Many of these symptoms are regularly perceived as oil related, because often higher quality oils and/or more frequent oil changes can reduce the problem. Additional filtration and use of detergent fuels (as offered by most fuel companies) can also reduce the severity of some of these symptoms.

However, Walker says "these are bandaid remedies to a combustion problem. Make no mistake about it, they treat the symptom not the cause.

Walker explained that extending the final boiling point of diesel fuel and increased secondary processing has affected combustion efficiency.

Recent oil analysis studies using the ferrous picrate combustion catalyst (a special type of fuel additive) have quantified reductions in engine wear rates, due to a clearner fuel burn and reduced accumulation of soot in the lube oil. According to Walker, "soot is a good abrasive — it works like valve grinding paste, only a bit slower."

Figure two graphically shows the response to catalyst treatment in a Cummins KTA 38 engine from a fleet of coal haulers. The wear rate is expressed as parts per million of iron per hour, and has been corrected for oil consumption.

For this unit, a wear reduction of 18% was also accompanied by reduced black smoke emissions and a 63% reduction in oil consumption. The regular incidence of valve dropping that had characterised this Cummins fleet has virtually been eliminated.

For this mine, the saving of just one valve failure has more than covered the cost of using the ferrous picrate catalyst for a whole year.

Long term ferrous picrate users have credited the catalyst with extensions in engine life of 15 to 100%, with typical high soot engines benefitting the most.

Brid Walker is regional manager of Fuel Technology Pty Ltd. PO Box 100, Darra, Queensland, 4076. Ph (07) 271 4138.

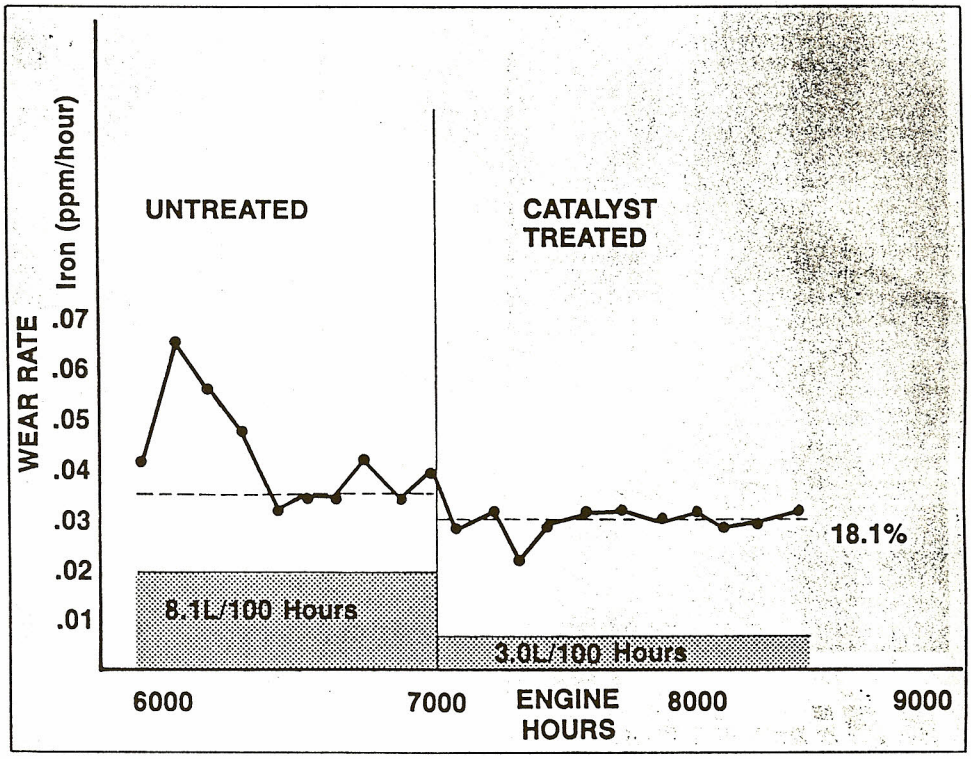

Figure one

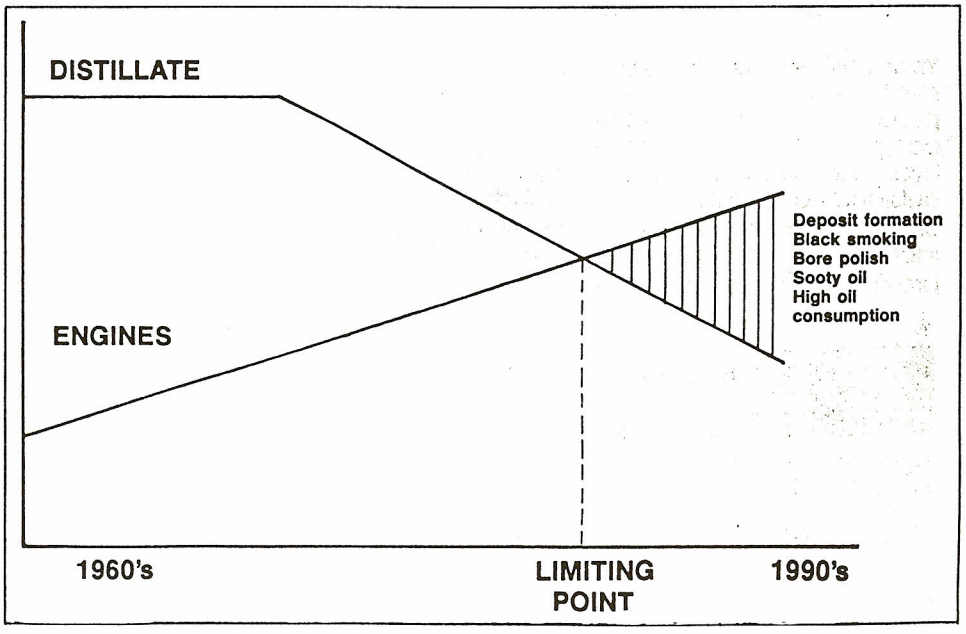

Figure two