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Los Alamos
NATIONAL LABORATORY

Los Alamos National Laboratory
Los Alamos, New Mexico 87545

Date: November 15, 2001
In Reply Refer To: ESH-18/WQ&H:01-387
Mail Stop: K497
Telephone: (505) 667-7969

1942 Report

Ms. Marlene Sundheimer
Water Division Director
City of Santa Fe
801 West San Mateo
Santa Fe, New Mexico 87504

SUBJECT: LOS ALAMOS NATIONAL LABORATORY, PERCHLORATE METHOD DETECTION LIMIT (MDL) STUDY

Dear Ms. Sundheimer:

During our meeting with you and your staff on Friday, October 12, 2001, at your Santa Fe office, we briefly described for you a study that Los Alamos National Laboratory (Laboratory) was conducting on the Method Detection Limit (MDL) for perchlorate in drinking water. I would like to take this opportunity to share with you some of the preliminary findings from this study.

Overview. For the past 18 months the Laboratory has been conducting routine monitoring of the Los Alamos Water Supply Wells for perchlorate. Samples are submitted to two independent analytical laboratories for perchlorate analysis: General Engineering Laboratories (GEL), Charleston, SC (MDL is ~ 1ppb), and E.S. Babcock & Sons (Babcock), Riverside, CA (MDL is ~ 2ppb). What follows is a brief summary of the analytical results obtained over the past 18 months.

Perchlorate was first detected in a water supply well in June 2000 at O-1. Since then, 40 perchlorate samples were collected from O-1. The results can be summarized as follows:

- 30 detections for perchlorate from 40 samples (30/40, 75% detection frequency),
- 28 qualified detections ('J flagged' detections ranging from 1.1 ppb to 3.9 ppb),
- 2 unqualified detections (5 ppb, 5.9 ppb),
- 10 of the 30 detections were from13 samples run by GEL (10/13, 77%),
- 20 of the 30 detections were from 27 samples run by Babcock (20/27, 74%), and
- 10 non-detects.

Both GEL and Babcock have consistently reported low-level detections of perchlorate from O-1. The data show good agreement between GEL and Babcock results; 77% of GEL results are detects while 74% of Babcock results are detects. The quantities reported by both GEL and Babcock, however, vary widely from 1.1 ppb to 5.9 ppb. The data suggest that at concentrations below 4 ppb analysis by Ion Chromatography (IC) may be effective at determining the presence or absence of perchlorate, but is not effective at accurately measuring the quantity of perchlorate in the sample. In conclusion, the 75% detection frequency at O-1 strongly indicates that perchlorate is present in the well water at a concentration between 1 ppb and 4 ppb.

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Since April 2001, perchlorate detections have also been reported at water supply wells PM-1, PM-3, PM-5, O-4, and G-5A. All detections were reported by GEL. Babcock did not report any perchlorate detections at these five wells. During CY2001, the percent of GEL detections for PM-1, PM-3, PM-5, O-4, and G-5A are as follows:

- PM-1: 50% of results are detections (1 detection in 2 samples, 1/2),
- PM-2: 0% detects (0/2),
- PM-3: 43% detects (7/16),
- PM-4: 0% detects (0/2),
- PM-5: 33% detects (5/15),
- O-4: 50% detects (1/2),
- G-1A: 0% detects (0/2),
- G-2A: 0% detects (0/2),
- G-3A: 0% detects (0/2),
- G-4A: 0% detects (0/2),
- G-5A: 57% detects (4/7), and
- *Overall: 33% detects (18/54).*

Detections at PM-1, PM-3, PM-5, O-4, and G-5A have a distinctively different profile than those at water supply well O-1. First, the frequency of detections at these five wells ranges from 33% to 57%, far lower than the frequencies seen at O-1. And second, as indicated previously, all detections at these five wells have been reported by GEL alone; Babcock has never reported a perchlorate detection in a water supply well with the exception of O-1. The randomness of the GEL data suggests that their MDL of 0.958 ppb may be too low to prevent the reporting of false positives. The CY2001 data do not substantiate the presence of perchlorate in PM-1, PM-3, PM-5, O-4, and G-5A. Further, the CY2001 data prompted the Laboratory to conduct a study to determine what the actual or effective MDL is for perchlorate.

MDL Determination. Analytical laboratories determine their MDL for perchlorate using deionized water. Ground water, in contrast, contains a wide variety of naturally occurring ions. During analysis these ions can create interference resulting in a less precise measurement. The precision obtained in deionized water cannot be duplicated in natural water. The inconsistencies in the perchlorate data collected from the Los Alamos Water Supply Wells suggest that interference occurs and that the actual detection limit is higher than the calculated MDLs reported by GEL and Babcock.

Following the recommendation of Mr. Mark Minteer, Analytical Quality Associates, Inc., in September 2001 the Laboratory initiated a Perchlorate MDL Study. Samples from water supply wells PM-3, PM-5, O-1, and G-5A were spiked as follows: (1) GEL samples at 1 ppb, 2 ppb, 4 ppb, and 6 ppb; and (2) Babcock samples at 2 ppb, 4 ppb, and 6 ppb. The enclosed Table 1.0 presents a summary of the study's results. A discussion of the results follows.

The perchlorate results reported by GEL for the unspiked samples from PM-3, PM-5, and G-5A are highly uncertain. Fifty percent (50%) of the unspiked analyses from PM-3, PM-5, and G-5A were detections. This detection frequency is consistent with GEL's CY2001 data reported earlier in this letter (33% to 57% detection frequency for all wells except O-1). These data suggest further that GEL's MDL of 0.958 ppb may be too low to provide consistent results and prevent the reporting of false positives.

The perchlorate results reported by GEL for PM-3, PM-5, and G-5A suggest that the measurements have a high bias in the 1 ppb, 2 ppb, and 4 ppb spiked samples. The table below presents the average of all detections for each sample type. For the 1 ppb spiked samples, the average for the 12 detections reported at these three wells is 2.5 ppb with a high bias of approximately 1.5 ppb. At 2 ppb, results from PM-3, PM-5, and G-5A become more consistent, but continue to show a uniformly high bias of approximately 1.3 ppb. The bias diminishes to 0.7 ppb for the 4 ppb spiked samples and to 0 ppb for the 6 ppb spiked samples. The data show a good correlation between instrument accuracy and the concentration of perchlorate in the sample.

Sample Type	**Average of All Detections PM-3, PM-5, G-5A**	**Bias**
1 ppb spike	2.5	+1.5
2 ppb spike	3.3	+1.3
4 ppb spike	4.7	+0.7
6 ppb spike	6.0	0

The GEL results for water supply well O-1 are markedly different than the results from PM-3, PM-5, and G-5A. All (100%) of the unspiked analyses from O-1 were detections. While the 1 ppb and 2 ppb spiked results are more consistent than those same samples from PM-3, PM-5, and G-5A, they do not accurately display the progression that is expected (ie, unspiked results+1 ppb+2 ppb, etc.). This suggests further that the method's capability to quantify below 4 ppb is limited.

The enclosed (Attachment 5.0) report from Mr. Minteer details his findings from the Perchlorate MDL Study data. In summary, Mr. Minteer recommends that LANL adopt an MDL for perchlorate that is no lower than 4 ppb. Mr. Minteer believes that the sensitivity of the IC is not adequate to produce reliable results at GEL's calculated MDL of 1 ppb.

Before implementing Mr. Minteer's recommendation, the Laboratory is collecting additional data for the Perchlorate MDL Study using a new analytical laboratory, Acculabs. Acculabs has the capability of analyzing for perchlorate using a more specific method, Liquid Chromatography/Mass Spec/Mass Spec (LC/MS/MS).

Buckman Well Field Data. As you recall, on August 16, 2001, personnel from the Laboratory and Tech Law (a subcontractor to the EPA Region 6) collected samples from Buckman wells #1, #2, and #7 and submitted to both GEL and Babcock for perchlorate analysis. The results were as follows:

	GEL Results	Babcock Results
• Buckman well #1	Nondetect	Nondetect
• Buckman well #2	Nondetect	Nondetect
• Buckman well #7	0.999J mg/L	Nondetect
• Buckman well #7 duplicate sample	Nondetect	Not available

Note: The GEL result for Buckman well #7 (0.999J mg/L) was qualified as an estimated detection (J flag) because the sample result was less than GEL's Reporting Limit (RL) of 4.00 mg/L, but greater than their Detection Limit (DL) of 0.958 mg/L.

The low detection frequency from GEL (1 detection in 4 samples, 25%) coupled with the nondetects from Babcock strongly suggests that the perchlorate detection at Buckman #7 is a false positive result. Certainly, any conclusions regarding the presence of perchlorate in Buckman #7 should be withheld until a larger data set can be obtained.

On October 31, 2001, personnel from the Laboratory and Tech Law (a subcontractor to the EPA Region 6) sampled all of the Buckman Water Supply Wells with the exception of Buckman #5 that was out-of-service at the time of sampling. Samples were submitted for perchlorate analysis to GEL, Babcock, and the Laboratory's new analytical laboratory, Acculabs. These results will be reported to you as soon as they become available.

Please contact me at (505) 667-7969 should you have any questions regarding this matter.

Sincerely,

Bob Beers
Water Quality and Hydrology Group

BB/tml

Enclosures: a/s

Cy: D. Doremus, City of Santa Fe, Santa Fe, NM, w/enc.
A. Lewis, City of Santa Fe, Santa Fe, NM, w/enc.
R. Mayer, EPA, Region 6, Dallas, TX, w/enc.
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M. Johansen, DOE/LAAO, w/enc., MS A316
K. Agogino, DOE/ABQ, Albuquerque, NM, w/enc.
J. Holt, AD-O, w/enc., MS A104
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Cy (continued):
P. Thullen, ESH-DO, w/enc., MS K491
D. Stavert. ESH-DO, w/enc., MS K491
S. Rae, ESH-18, w/enc., MS K497
B. Gallaher, ESH-18, w/enc., MS K497
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C. Nylander, ESH-18, w/enc., MS K497
WQ&H File, w/enc., MS K497
IM-5, w/enc., MS A150

Table 1.0. Summary of Perchlorate Study Analytical Results. Sample Date: 9/5/2001. All units are ug/L (ppb).

	O-1		PM-3		PM-5		G-5A	
Sample Type	**Babcock**	**GEL**	**Babcock**	**GEL**	**Babcock**	**GEL**	**Babcock**	**GEL**
Initial Sample	<2	3.86	<2	<0.958	<2	2.05	<2	<0.958
Initial Sample Rerun #1	<2	3.24	<2	<0.958	<2	<0.958	<2	<0.958
Initial Sample Rerun #2	<2	2.55	<2	1.47	<2	1.493	<2	1.474
Initial Sample Rerun #3	NA	3.07	NA	<0.958	NA	1.663	NA	1.287
Initial Sample Rerun #4	NA	2.92	NA	1.62	NA	<0.958	NA	<0.958
Dupe Sample	<2	3.53	<2	2.56	<2	<0.958	<2	2.61
1 ppb Spike	NA	3.87	NA	3.49	NA	1.3	NA	<0.958
1 ppb Spike Rerun #1	NA	3.53	NA	1.86	NA	3.267	NA	1.88
1 ppb Spike Rerun #2	NA	3.88	NA	<0.958	NA	2.58	NA	3.026
1 ppb Spike Rerun #3	NA	3.77	NA	2.67	NA	1.505	NA	<0.958
1 ppb Spike Rerun #4	NA	3.87	NA	3.49	NA	1.295	NA	3.058
2 ppb Spike	2.7	4.22	<2	3.90	<2	2.3	3.1	3.24
2 ppb Spike Rerun #1	<2	4.52	<2	3.21	<2	3.525	<2	3.56
2 ppb Spike Rerun #2	<2	4.91	<2	3.57	<2	3.2	<2	3.269
2 ppb Spike Rerun #3	NA	4.56	NA	3.60	NA	3.37	NA	3.455
2 ppb Spike Rerun #4	NA	4.69	NA	3.00	NA	3.594	NA	3.015
4 ppb spike	6	6.59	4	4.16	4	3.72	5	6.19
6 ppb spike	7	7.56	6	5.72	7	6.88	7	5.42

ATTACHMENT 1.0

REPORT ON PERCHLORATE MDL STUDY RESULTS

ANALYTICAL QUALITY ASSOCIATES, INC.
616 MAXINE NE
ALBUQUERQUE, NM 87123

NOVEMBER 2, 2001

Analytical Quality Associates, Inc.
616 Maxine NE
Albuquerque, NM 87123
Phone: 505-299-5201
Fax: 505-299-6744
Email: minteer@aol.com

To: Bob Beers, William Turney, and Ken Mullen (LANL ESH)
From: Mark Minteer (AQA/DOE-AL Analytical Management Program)
Date: 11/2/01
Re: ClO_4 detection limit study results

Background and Summary:

The method detection limit for perchlorate (ClO_4) by ion chromatography (IC), as calculated by GEL according to the specifications of 40 CFR 136, is 1 ppb. We have shown empirically that for ClO_4 by IC, as with previous results for some GC and HPLC techniques, the high precision attainable for low-level standards in clean (DI) water leads to calculated detection limits that are demonstrably lower than the limit of sensitivity of the instrument.

Pantex, LANL ESH, and LANL ER have all seen unexpected, random low-level hits for ClO_4 by IC. Matrix-specific MDL verification studies run for Pantex in late 2000 and early 2001 showed that ClO_4 can not be detected at the calculated 1 ppb MDL for IC when run in a real Ogallala aquifer groundwater matrix. Pantex adopted a 4 ppb MDL for ClO_4 after reviewing those data (see Attachment One). Additional data were recently acquired using groundwater from Los Alamos, with similar results. The data for groundwater matrices from both DOE-AL facilities show significant random variations in background (noise) that lead to frequent false positives. Based upon the data acquired in the new MDL verification studies, the GEL IC chemist (Bob Sosa) and DOE-AL Analytical Management Program staff recommend that LANL ESH also adopt an MDL level for ClO_4 run by IC that is <u>no lower than 4 ppb</u>.

Discussion of LANL groundwater results:

LANL ESH personnel sent a number of groundwater samples to GEL during October 2001 to support the investigation. Those samples included unspiked water from four wells, as well as the same water spiked with 1, 2, 4, and 6 ppb of ClO_4. The unspiked samples, together with the 1 and 2 ppb spikes, were run in quadruplicate. The 4 and 6 ppb spikes were run once each. The data obtained were summarized in tabular form by Deidre (Dee) Reilly of GEL and are presented in Attachment Two.

Three out of four of the unspiked samples show results that vary randomly between zero and the mid-1 ppb range. Results obtained by the method of standard additions (MSA) for those three samples, while run on very low concentration standards, are all below the calculated 1 ppb MDL (see Attachment Three for MSA results). Taken together, these data suggest that either there is no perchlorate in the samples or the analyte is well below the instrument's ability to detect. To provide typical examples of the mid-1 ppb results, we obtained chromatograms for the G5MP unspiked sample run that gave the 1.493 ppb result. These chromatograms show the retention time of interest using both the standard y-axis scale and a 10X expanded scale (see Attachment Four). The ClO_4 result changed slightly when the chromatogram was reprocessed on the 10X

scale, but the conclusion is the same. It is clear that the 1 ppb level is well inside the instrument noise in this matrix, and is hence unreliable as a detection limit.

If we look at the data obtained on the 1 ppb spikes of the three samples that showed no reliable ClO_4 hits, we see once again that the data appear to vary randomly with a slightly higher bias. We still obtain 2 zero results among the 12 runs, but the high result is now 3.494 ppb.

Sample G5MP was run 10 times with a 4 ppb spike added. In that data set (see Attachment Five), two of the results were less than 4 ppb. That is, 20% of the results would have been non-detects at a 4 ppb MDL. One of the results was greater than 50% high, one was 38% high, and the data set average was 4.47 ppb. That is, there is also a significant probability of obtaining false positives at a 4 ppb MDL. Using the 40 CFR 136 calculation approach, this data set supports using a significantly higher MDL of 2.57 ppb. However, the 4 ppb standard concentration used here would be at the extreme low end of the concentration range specified in 40 CFR 136 for MDL determination standards. Using standards at such low concentrations in MDL studies typically yields unreasonably low MDLs. The remaining statistics for that data set are given below.

$\bar{X}$	=	4.47 ppb
σ_{N-1}	=	0.913 ppb
High	=	6.30 ppb
Low	=	3.11 ppb
Range	=	3.19 ppb

For this data set, we would have about 20% false negatives, and at least 20% false positives. The standard deviation of this data set is approximately 25% of the spike added, and the mean shows a general high bias. From this data set it is clear that the accuracy and precision attainable by IC make a 4 ppb MDL something of a stretch. Using an MDL that is lower than 4 ppb would make it very likely that the reported results would be significantly erroneous.

In summary, we have shown that that the sensitivity of IC is not adequate to produce reliable results at the (40 CFR 136) calculated 1 ppb MDL. The empirical data we have acquired additionally suggest that using any detection limit below 4 ppb in real LANL groundwater matrix will result in unacceptably high percentages of false positives and false negatives. We recommend 4 ppb as the lowest possible MDL that should be reported when analyzing ClO_4 by IC. Additional data are being acquired at present, and we will complete our evaluation when those data become available.

cc: Dave Bourne (DOE)
Keith Greene (LANL ER)
Bill Wyatt (Pantex)
Pam Puissant (Sandia)
Gary Dechant (AQA)

Attachment One

Mason & Hanger Corporation
A Subsidiary of
Day & Zimmermann, Inc.

Date: November 28, 2000

From: W.R. Wy[illegible] **Location:** S&A, 18-1

To: S&A File **Location:**

Subject: Detection Limits for Perchlorates

On November18, 2000 General Engineering Laboratories (GEL) was requested to verify the method detection limit (MDL) of 1.0 µg/L for perchlorate established using deionized laboratory reagent water. The verification was performed on two samples of local groundwater (Ogallala). The lab could not reliably detect perchlorate at either 1.0 and 1.7 µg/L. Perchlorate was detected in one of the samples at 4.0 µg/L. GEL was requested to elevate their MDL to 4.0 µg/L for natural waters which would be expected to contain interfering anions.

All detections for perchlorate below 4.0 µg/L should be treated as not detected. Sample results in the IEDb should be evaluated against this criteria and changed accordingly. The report from GEL and email communication is attached for reference.

cc: file

Attachments as stated

Table 2
Pantex Matrix Spike

Spike Conc. (ug/L)	Sample	Found	% Recovery
4.0	Not Detected	3.8	95%
1.7	Not Detected	Not Detected	N/A
1.0	Not Detected	Not Detected	N/A

The DI spike study shows that the laboratory has very good accuracy and precision when concentrations fall near the PQL. The study also shows that concentrations below that level, while detected, do not reflect good precision.

The sample spike study shows that the sample matrix, as expected, had considerable baseline rise. While the 4.0 ug/L spike exhibited good recovery, the other concentrations were not even detected. As Ms. Reilly had explained, the instrument software has a difficult time assigning peaks when the instrument response is this low, especially considering the background matrix of the samples in question. This may be causing the lack of detection at these spiking concentrations.

To summarize the study, we believe that sample concentrations below the PQL for Pantex samples show high variability due to the sample matrix. Concentrations found below the PQL are considered questionable and may not truly indicate true concentration or detection. If you have additional questions on this study, or would like to review the raw data files please call me at (843) 556-8171.

Your very truly,

Robert L. Pullano
Quality Systems Manger

Fc: PNTX

Cc: Bill Wyatt (Pantex)
Gary Dechant (AQA)
Scott Hall (GEL)
Carey Bocklet (GEL)
Deidre Reilly (GEL)

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GENERAL ENGINEERING LABORATORIES

Meeting today's needs with a vision for tomorrow

November 18, 2000

Mr. Mark Minteer
Analytical Quality Associates, Inc.
616 Maxine NE
Albuquerque, NM 87123

Re: Follow-up to Perchlorate Quantitation Limit Verification

Dear Mr. Minteer,

General Engineering Laboratories, Inc. (GEL) has completed the verification study as described in Ms. Reilly's November 3rd letter. As explained by Ms. Reilly, GEL has analyzed groundwater samples for perchlorate for several clients. Samples from the Pantex site consistently show more matrix interference than those from other sites. This often results in a baseline that is not nearly as level as other samples or laboratory process controls that are made in deionized water (DI).

A study was performed to verify the instrument detection capabilities, accuracy, and precision for deionized spiked standards and Pantex matrix spikes. It was our initial conclusion that the estimated results reported on the Pantex samples were caused by interferences from the sample matrix and that the data should be considered estimated.

The laboratory analyzed seven standards prepared at the Practical Quantitation Limit (PQL) of 4.0ug/L, seven standards prepared at 1.7 ug/L, and seven standards prepared at 1.0 ug/L (which is the current Method Detection Limit). Results of the study are summarized in Table 1. The laboratory also spiked one Pantex sample at the same concentrations. Results from this study are summarized in Table 2.

Table 1
De-Ionized Water Spike

Known Conc. (ug/L)	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Average (ug/L)	Stdev	Avg. Recovery
4.0	4.1	3.8	3.1	3.1	4.9	3.8	3.8	3.8	0.62	95%
1.7	0.5	0.5	1.7	2.5	1.7	3.3	1.7	1.7	1.01	100%
1.0	1.4	0.2	1.4	1.8	0.6	0.5	1.5	1.1	0.61	110%

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From: <Minteer%aol.com@internet.pantex.com>
To: <rip%gel.com@internet.pantex.com>
Date: 11/27/00 4:25PM
Subject: ClO4 reporting limit

Bob:

Based upon the data you have sent to Bill Wyatt and me, it is clear that you cannot detect ClO4 in Pantex samples at your 1 ppb reporting limit. Your data suggest to us that we should artificially elevate the detection limit, consistent with the spirit of Model SOW section 3.3.1 (a) (iv), to 4 ppb. Please ensure that future reported detection limits conform to this guideline. In addition, we suggest that it might be beneficial to try similar experiments with other natural waters. You might find that your ClO4 reporting limits should be elevated in a more broadly general sense and not just for Pantex.

Regards,
Mark Minteer
AQA/DOE-AL Analytical Management Program

CC: <GLDechant%aol.com@internet.pantex.com>, <dbourne%doeal.gov@internet.pantex.com>, <cjb%gel.com@internet.pantex.com>, <kmullen%lanl.gov@internet.pantex.com>, <shagelbe%lanl.gov@internet.pantex.com>, <wwyatt@pantex.com>, <CMOKE@pantex.com>, <tvincent@pantex.com>, <tlawler@pantex.com>, <drsalmi%sandia.gov@internet.pantex.com>, <pmpuiss%sandia.gov@internet.pantex.com>

Attachment Two

LANL Perchlorate MDL Verification

GEL ID	Client ID	Result (ug/L)	Date	Time	Analyst
48671005	GU01091G5MP	0.000	10/3/01	20:25	RWS
		1.493	10/3/01	20:35	RWS
		1.663	10/3/01	20:44	RWS
		0.000	10/3/01	20:54	RWS
49768003	GU01091G5MP1	3.267	10/3/01	12:32	RWS
		2.580	10/3/01	12:41	RWS
		1.505	10/3/01	12:51	RWS
		1.295	10/3/01	13:01	RWS
48671006	GU01091G5MP2	3.525	10/3/01	21:04	RWS
		3.200	10/3/01	21:14	RWS
		3.370	10/3/01	21:24	RWS
		3.594	10/3/01	21:34	RWS
48761007	GU1091G5MP4	3.72	9/13/01	12:47	RWS
48761008	GU1091G5MP6	6.88	9/13/01	17:16	RWS
48671004	GU01091G1RG	0.000	10/3/01	19:45	RWS
		1.474	10/3/01	19:55	RWS
		1.287	10/3/01	20:05	RWS
		0.000	10/3/01	20:15	RWS
49768001	GU01091G1RG1	1.880	10/3/01	10:43	RWS
		3.026	10/3/01	10:53	RWS
		0.000	10/3/01	11:03	RWS
		3.058	10/3/01	11:13	RWS
48671009	GU01091G1RG2	3.560	10/3/01	21:44	RWS
		3.269	10/3/01	21:54	RWS
		3.455	10/3/01	22:03	RWS
		3.015	10/3/01	22:13	RWS
48761010	GU1091G1RG4	6.19	9/14/01	16:20	RWS
48761011	GU1091G1RG6	5.42	9/17/01	18:23	RWS

LANL Perchlorate MDL Verification

GEL ID	Client ID	Result (ug/L)	Date	Time	Analyst
48671024	GU01091G1OW	3.236	10/3/01	23:42	RWS
		2.545	10/3/01	23:52	RWS
		3.066	10/4/01	00:02	RWS
		2.918	10/4/01	00:12	RWS
49768004	GU01091G1OW1	3.531	10/3/01	13:11	RWS
		3.876	10/3/01	13:21	RWS
		3.771	10/3/01	13:31	RWS
		3.871	10/3/01	13:41	RWS
48671014	GU01091G1OW2	4.516	10/3/01	22:23	RWS
		4.906	10/3/01	22:33	RWS
		4.558	10/3/01	22:43	RWS
		4.693	10/3/01	22:53	RWS
48761015	GU1091G1OW4	6.59	9/17/01	18:44	RWS
48761016	GU1091G1OW6	7.56	9/17/01	18:54	RWS
48671030	GU01091G3MP	0.000	10/4/01	00:22	RWS
		1.468	10/4/01	00:31	RWS
		0.000	10/4/01	00:41	RWS
		1.616	10/4/01	00:51	RWS
49768002	GU01091G3MP1	1.856	10/3/01	11:32	RWS
		0.000	10/3/01	11:42	RWS
		2.665	10/3/01	12:12	RWS
		3.494	10/3/01	12:22	RWS
48671017	GU01091G3MP2	3.214	10/3/01	23:03	RWS
		3.567	10/3/01	23:13	RWS
		3.596	10/3/01	23:22	RWS
		2.996	10/3/01	23:32	RWS
48761018	GU1091G3MP4	4.16	9/17/01	19:04	RWS
48761019	GU1091G3MP6	5.72	9/17/01	19:14	RWS

Attachment Three

Deidre Reilly

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LANL Perchlorate MSA Study

GEL ID	Client ID	Result (ug/L)	Date	Time	Analyst	
49641001	GU01081G1MP	2.120	8/28/01	13:20	RWS	
	GU01081G1MP	0.000	10/3/01	14:29	RWS	corr. coef. = 0.995
	+ 1 ug/L spike	1.862	10/3/01	14:39	RWS	MSA result = 0.118875
	+ 2 ug/L spike	3.048	10/3/01	14:49	RWS	
	+ 3 ug/L spike	4.394	10/3/01	14:58	RWS	
49641002	GU01081G1OW	3.480	8/30/01	12:59	RWS	
	GU01081G1OW	2.469	10/3/01	15:08	RWS	corr. coef. = 0.985
	+ 2 ug/L spike	4.854	10/3/01	15:18	RWS	MSA result = 3.386246
	+ 4 ug/L spike	6.397	10/3/01	15:28	RWS	
	+ 6 ug/L spike	7.490	10/3/01	15:38	RWS	
49641003	GU01081G4OW	1.650	8/30/01	13:19	RWS	
	GU01081G4OW	0.000	10/3/01	15:48	RWS	corr. coef. = 0.886
	+ 1 ug/L spike	2.498	10/3/01	15:58	RWS	MSA result = 0.576778
	+ 2 ug/L spike	3.730	10/3/01	16:27	RWS	
	+ 3 ug/L spike	3.488	10/3/01	18:26	RWS	
49641004	GU01081G1RG	1.750	8/30/01	23:19	RWS	
	GU01081G1RG	0.000	10/3/01	18:36	RWS	corr. coef. = 0.823
	+ 1 ug/L spike	4.092	10/3/01	16:57	RWS	MSA result = 0.797272
	+ 2 ug/L spike	3.536	10/3/01	17:07	RWS	
	+ 3 ug/L spike	4.633	10/3/01	17:17	RWS	
49641005	GU01081BUCK7	0.999	9/6/01	16:09	RWS	
	GU01081BUCK7	0.000	10/3/01	17:27	RWS	corr. coef. = 0.881
	+ 0.5 ug/L spike	0.000	10/3/01	17:36	RWS	MSA result = -0.115752
	+ 1 ug/L spike	2.594	10/3/01	17:46	RWS	
	+ 1.5 ug/L spike	2.447	10/3/01	17:56	RWS	

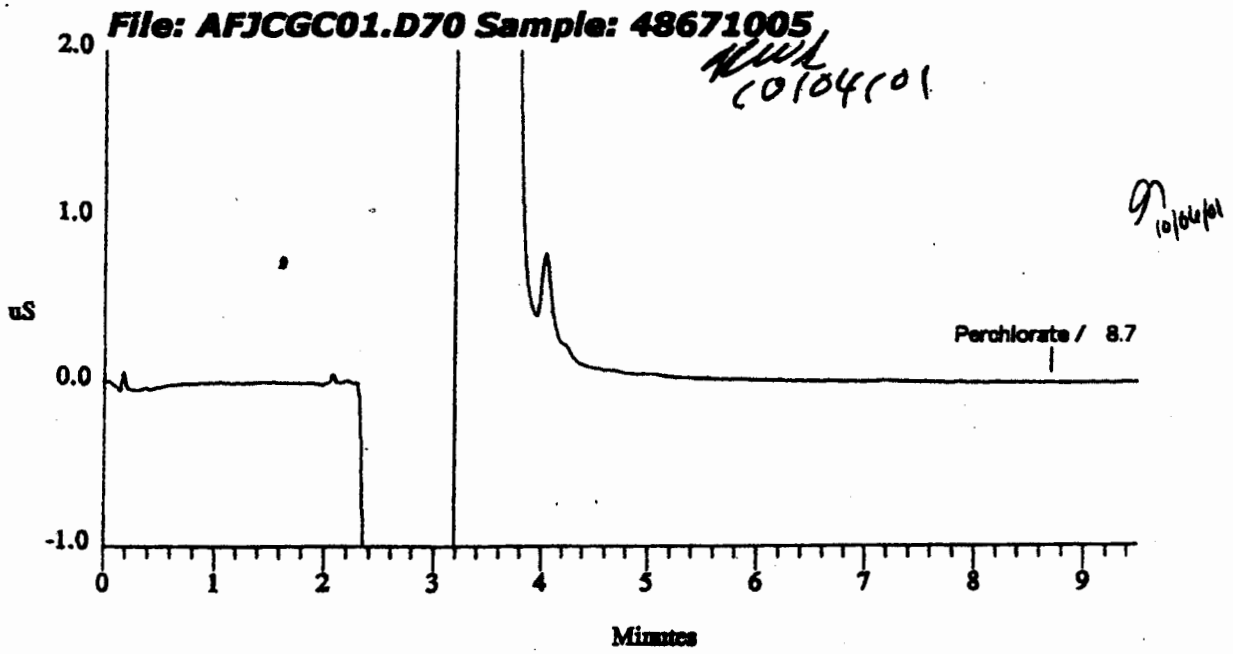
Attachment Four

Sample Name: 48671005	Date: 10/03/2001 20:35:03
Data File : C:\TMP\HORIZON\AFJCGC01.D70	
Method : C:\DX\METHOD\AFAS16.MET	
ACI Address: 1 System: 1 Inject#: 70	Detector:CDM-2
Analyst : RWS	Column: AS16 #1916;SOP: GL-GC-E-086;314

Calibration	Volume	Dilution	Points	Rate	Start	Stop	Area Reject
External	1	1	2850	5Hz	0.00	9.50	0

********** Component Report: All Components **********

Pk. Num	Ret Time	Component Name	Concentration ug/l	Height	Area	Bl. Code	%Delta
1	8.71	Perchlorate	1.493	6310	45944	1	0.00
		Totals	1.493	6310	45944		



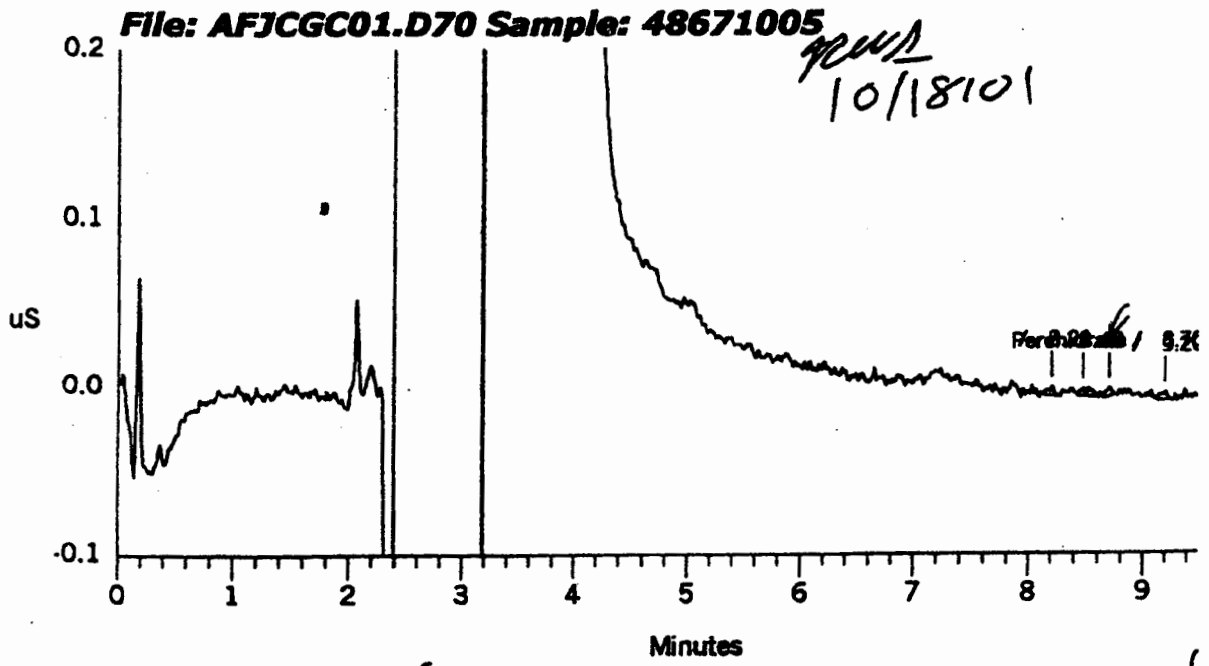
Data Reprocessed On 10/18/2001 08:26:00

Sample Name: 48671005	Date: 10/03/2001 20:35:03
Data File : F:\AFJCGC01.D70	
Method : C:\DX\METHOD\AFAS16.MET	
ACI Address: 1 System: 1 Inject#: 70	Detector:CDM-2
Analyst : RWS	Column: AS16 #1916;SOP: GL-GC-E-086;314

Calibration	Volume	Dilution	Points	Rate	Start	Stop	Area Reject
External	1	1	2850	5Hz	0.00	9.50	0

********** Component Report: All Components **********

Pk. Num	Ret Time	Component Name	Concentration ug/l	Height	Area	Bl. Code	%Delta
3	8.70	Perchlorate	1.304	5304	19752	1	0.00
		Totals	1.304	5304	19752		



This chromatogram was reprocessed so the perchlorate could be more easily seen.

Attachment Five

LANL Perchlorate MDL Verification

GEL ID	Client ID	Result (ug/L)	Date	Time	Analyst
48671005	GU01091G5MP	0.000	10/3/01	20:25	RWS
		1.493	10/3/01	20:35	RWS
		1.663	10/3/01	20:44	RWS
		0.000	10/3/01	20:54	RWS
48671005	GU01091G5MP + 4 ug/L spike	4.232	10/18/01	11:21	RWS
		5.508	10/18/01	11:32	RWS
		3.113	10/18/01	11:42	RWS
		4.526	10/18/01	11:52	RWS
		6.305	10/18/01	12:03	RWS
		4.290	10/18/01	12:13	RWS
		4.094	10/18/01	12:23	RWS
		3.901	10/18/01	12:34	RWS
		4.944	10/18/01	12:44	RWS
		3.816	10/18/01	12:54	RWS

$\bar{X} = 4.47$

$\sigma_{n-1} = 0.913$

high = 6.30

Low = 3.11

range = 3.19