

Interpreting Your CSIA Report

Mike O'Seeps, Ph.D.

Microseep, Inc.
220 William Pitt Way
Pittsburgh, PA 15238



20-Feb-08
P0899999
Client Name
Client Project Name: CSIA Project
Client Project #: 0000-00

Vinyl Chloride		Concentration			CSIA (Carbon)					
		(ug/l)			Area (Vs)		Co-elution	Analysis	Date	Del (‰)
Lab ID	Client ID	Sample	PQL	Date	Sample	PQL				
P0899999-01	MW-1	<5 (U)	5	2/4/08	<1 (U)	1	No	4052	2/15/08	-
P0899999-02	MW-2	5 (J)	5	2/4/08	<1 (U)	1	No	4060	2/16/08	-
P0899999-03	MW-3	2000	200	2/5/08	11.3	1	No	4063	2/16/08	-26.49
P0899999-04	MW-4	9	5	2/4/08	3.6	1	No	4062	2/16/08	-28.19



For many of you this is the first CSIA report you have received from Microseeps. Because this analysis is different than the concentration analyses that are typically obtained from a laboratory, this report is a bit unusual. This is an attempt to help you understand the report and how to use it. This document will focus on the report itself and how its content relates to your samples. It does not attempt to interpret the results in terms of site remediation. There are some excellent references that can help with that and they will be discussed at the end of this document.

Area

The CSIA section of the report specifies area, not concentrations. The instrument used in CSIA can provide very sensitive and accurate measurements of concentration, that is not its purpose. The CSIA instrument is operated to provide sensitive and accurate isotopic ratio measurements, not concentration measurements. SW846-8260B and EPA-624 are excellent methods for measuring concentration.

The CSIA instrument is operated to provide sensitive and accurate isotopic ratio measurements, not concentration measurements.

CSIA (Carbon)			
Area (Vs)		Co-elution	Anal
Sample	PQL		
<1 (U)	1	No	40
1 (U)	1	No	
1			

Microseeps' CSIA quality control (QC) program has been modeled after those methods because they use a very good and widely recognized QC program, but for measuring concentration CSIA is not an alternative to those methods. As such, the CSIA section of Microseeps' laboratory report does not specify concentrations, but area. We report area in Vs, or volt-seconds. Area is generally proportional to concentration and area values are provided in your CSIA report so that two points can be assessed.

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Vinyl Chloride				Concentration (ug)		Area (Vs)		CSIA (Carbon)		Date	Del (%)
Lab ID	Client ID	Sample	PQL	Date	Sample	PQL	Co-elution	Analysis	Date	Del (%)	
P0899999-01	MW-1	<5 (U)	5	2/4/08	<1 (U)	1	No	4052	2/15/08	-	
P0899999-02	MW-2	<5 (U)	5	2/4/08	<1 (U)	1	No	4060	2/16/08	-	
P0899999-03	MW-3	2000	200	2/5/08	11.3	1	No	4063	2/16/08	-26.49	
P0899999-04	MW-4	9	5	2/4/08	3.8	1	No	4062	2/16/08	-28.19	
P0899999-05	MW-5	<5 (U)	5	2/5/08	<1 (U)	1	No	4053	2/16/08	-	
P0899999-06	MW-6	<5 (U)	5	2/5/08	<1 (U)	1	No	4054	2/16/08	-	
P0899999-07	MW-7	<5 (U)	5	2/5/08	<1 (U)	1	No	4055	2/16/08	-	
Dup (-03)	MW-3 (DF100)	-	-	-	10.8	1	No	4058	2/16/08	-28.52	
Blank		-	-	-	<1 (U)	1	No	4048	2/15/08	-	
LCS_Lo		-	-	-	13.7	1	No	4049	2/15/08	-28.05	
LCS_Hi		-	-	-	21.5	1	No	4050	2/15/08	-27.99	
LCS acceptance range								-27.50	<=>	-28.50	
Method	8260B				AM-24-AR_C				AM-24-DL_C		
Units	ug/l				Vs				%		
Analyst	hg				cm				cm		

PQL

As with any instrument, there is some minimum threshold of signal required for a reliable isotopic ratio to be accurately measured. The PQL (Practical Quantitation Limit) is a systematically determined “reporting limit” that gives the minimum area necessary to produce an isotopic ratio measurement accurate to within ± 0.5 per mil. The CSIA Standard Operating Procedure (SOP-AM24) gives the detailed procedure used for PQL determination. The measurement is somewhat less accurate, but still reliable, when the area is below the PQL.

Minimum signal strength – the reason behind the flags.

Area (Vs)		CSIA (C)	Co-elution	Am
Sample	PQL			
<1 (U)	1	No		40
<1 (U)	1	No		40
11.3	1	No		
	1	No		

The range of this accuracy is very matrix dependant, but through experience we have found that duplicates still match to within two or three per mil when the signal is at least 80% of the PQL, so it can be considered that the method detection limit (MDL) is 80% of the PQL. Any areas which lie between the MDL and PQL are flagged with a J. Areas that are less than the MDL are treated as “non-detects” and the area is reported as being less than the PQL and flagged with a “U”. The measured area is reported to the user so that they can see if the signal strength was sufficient and/or what flags should be put upon the data.

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P089999
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Vinyl Chloride		Concentration (ug/l)			Area (Vs)		CSIA (C) (ppm)		Date	Det (%)
Lab ID	Client ID	Sample	PQL	Dil	Sample	PQL	Co-elution	Analysis		
P089999-01	MW-1	<5 (U)	5	2/4/08	<1 (U)	1	No	4052	2/15/08	-
P089999-02	MW-2	5 (U)	5	2/4/08	<1 (U)	1	No	4060	2/15/08	-
P089999-03	MW-3	2000	200	2/5/08	11.3	1	No	4063	2/16/08	-26.49
P089999-04	MW-4	9	5	2/4/08	3.6	1	No	4062	2/16/08	-28.19
P089999-05	MW-5	<5 (U)	5	2/5/08	<1 (U)	1	No	4053	2/16/08	-
P089999-06	MW-6	<5 (U)	5	2/5/08	<1 (U)	1	No	4054	2/16/08	-
P089999-07	MW-7	<5 (U)	5	2/5/08	<1 (U)	1	No	4055	2/16/08	-
Dup (-03)	MW-3 (DF100)	-	-	-	10.8	1	No	4058	2/16/08	-28.52
Blank		-	-	-	<1 (U)	1	No	4048	2/15/08	-
LCS_Lo		-	-	-	13.7	1	No	4049	2/15/08	-28.05
LCS_Hi		-	-	-	21.5	1	No	4050	2/15/08	-27.99
LCS acceptance range								-27.50	<=>	-28.50
Method		8260B			AM-24-AR_C				AM-24-DL_C	
Units		ug/l			Vs				%	
Analyst		hg			cm				cm	



PQL – the details

- U – indicates either that there was no peak corresponding to the target analyte or that if there was such a peak, it had an area less than the MDL and did not produce a reliable CSIA result.
- J – indicates that the target analyte was found but the area of the peak it produced is less than the PQL but greater than the MDL (the MDL is 80% of the PQL). The result is considered usable to $\pm 1-2 \text{ ‰}$, but not the standard $\pm 0.5 \text{ ‰}$.

Co-elution

If a co-contaminant elutes from the chromatographic column with a target analyte, the CSIA measurement of that target analyte may not be entirely of a single compound, but may be corrupted by the presence of the co-eluting compound. According to AM-24 there are specific ways to evaluate the CSIA results for this and they produce a simple Yes/No answer, and they are spelled out on the following page. A positive co-elution result indicates the data may be suspect.

CSIA (Carbon)			
	Co-elution	Analysis	Date
PQL			
1	No	4052	2/15/08
1	No	4060	2/16/08
1	No	4063	2/16/08
1	No	4062	2/16/08

A positive co-elution result indicates the data may be suspect.

Why?

In CSIA, compounds are only separated as well as the gas chromatograph separates them. A concentration measurement such as an SW846-8260 then further distinguishes by mass. However, in CSIA all analytes are first combusted to carbon dioxide before the analytes enter the mass spectrometer. As such, an isotope ratio mass spectrometer, such as that used for CSIA, does not contribute to the identification of analytes.

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20-Feb-08
P089999-09
Client Name
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Vinyl Chloride		Concentration (ug/l)			CSIA (Carbon)				
Lab ID	Client ID	Sample	PQL	Date	Area (Vs)	Co-elution	Analysis	Date	
P089999-01	MW-1	<5 (U)	5	2/4/08	<1 (U)	1	No	4058	2/15/08
P089999-02	MW-2	<5 (U)	5	2/4/08	<1 (U)	1	No	4050	2/16/08
P089999-03	MW-3	2000	200	2/5/08	11.3	1	No	4063	2/16/08
P089999-04	MW-4	9	5	2/4/08	3.6	1	No	4062	2/16/08
P089999-05	MW-5	<5 (U)	5	2/5/08	<1 (U)	1	No	4053	2/16/08
P089999-06	MW-6	<5 (U)	5	2/5/08	<1 (U)	1	No	4054	2/16/08
P089999-07	MW-7	<5 (U)	5	2/5/08	<1 (U)	1	No	4055	2/16/08
Dup (-03)	MW-3 (DF100)	-	-	-	10.8	1	No	4058	2/16/08
Blank	-	-	-	-	<1 (U)	1	No	4048	2/15/08
LCS, Lo	-	-	-	-	13.7	1	No	4049	2/15/08
LCS, Hi	-	-	-	-	21.5	1	No	4050	2/15/08
LCS acceptance range	-	-	-	-	-	-	-	-	-

Method	8260B	AM-24-AR_C	AM-24-DL_C
Units	ug/l	vs	%
Analyst	hg	cm	cm



Co-elution – the details

Two ways to detect co-elution

- Peak Shape Assessment
 - Available directly from IRMS
 - Requires examination of detailed results
- Comparison with a standard GCMS concentration
 - Microseeps performs this comparison
 - Allows detection of “perfect” co-elutions that don’t affect peak shape

Analysis

A unique, sequential analysis number is automatically assigned to every analysis. The analysis number provided with each result identifies the analysis that measured the reported result. The data-user can use it as the cross-reference to the surrogate table.

Dilution	Analysis	Date	Del (‰)
No	4052	2/15/08	-
No	4060	2/16/08	-
No	4063	2/16/08	-26.49
	4062	2/16/08	-26.49

Through this unique identifier, each result is cross-referenced to the surrogate table.

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Lab ID	Client ID	Concentration		Area (Vs)		Surrogate (Carbon)				
		Sample	PQL	Sample	PQL	Zo-elution	Analysis	Date	Del (‰)	
P0899999-01	MW-1	<5 (U)	5	2/4/08	<1 (U)	1	No	4052	2/15/08	-
P0899999-02	MW-2	<5 (U)	5	2/4/08	<1 (U)	1	No	4050	2/16/08	-
P0899999-03	MW-3	2000	200	2/5/08	11.3	1	No	4063	2/16/08	-26.49
P0899999-04	MW-4	9	5	2/4/08	3.6	1	No	4062	2/16/08	-28.19
P0899999-05	MW-5	<5 (U)	5	2/5/08	<1 (U)	1	No	4053	2/16/08	-
P0899999-06	MW-6	<5 (U)	5	2/5/08	<1 (U)	1	No	4054	2/16/08	-
P0899999-07	MW-7	<5 (U)	5	2/5/08	<1 (U)	1	No	4055	2/16/08	-
Dup (-03)	MW-3 (DF 100)	-	-	-	10.8	1	No	4058	2/16/08	-28.52
Blank		-	-	-	<1 (U)	1	No	4048	2/15/08	-
LCS - Lo		-	-	-	13.7	1	No	4049	2/15/08	-28.05
LCS - Hi		-	-	-	21.5	1	No	4050	2/15/08	-27.99
LCS acceptance range										<=> -28.50

From that the data user can see what the area response of the surrogate was in that sample, what dilution was analyzed to get the reported result and what del was measured for the surrogate in that sample.

Del

This is the documented, validated and final CSIA result. It is linearly related to the isotopic ratio, but expressed in more convenient units. This is the result the data user most needs. How it relates to the measured values is discussed in SOP-AM₂₄, but other than for a one time data validation, that information is not required.

This is the documented, validated and final CSIA result.

	Del (‰)
08	-
08	-
8	-26.49
	-28.19

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Vinyl Chloride		Concentration				CSIA (Carbon)				
Lab ID	Client ID	Sample	PQL	Date	Sample	PQL	Co-elution	Analysis	Date	Del (%)
P0899999-01	MW-1	<5 (U)	5	2/4/08	<1 (U)	1	No	4052	2/15/08	-
P0899999-02	MW-2	<5 (U)	5	2/4/08	<1 (U)	1	No	4060	2/16/08	-
P0899999-03	MW-3	2000	200	2/5/08	11.3	1	No	4063	2/16/08	-26.49
P0899999-04	MW-4	9	5	2/4/08	3.6	1	No	4062	2/16/08	-28.19
P0899999-05	MW-5	<5 (U)	5	2/5/08	<1 (U)	1	No	4053	2/16/08	-
P0899999-06	MW-6	<5 (U)	5	2/5/08	<1 (U)	1	No	4054	2/16/08	-
P0899999-07	MW-7	<5 (U)	5	2/5/08	<1 (U)	1	No	4055	2/16/08	-
Dup (-03)	MW-3 (DF 100)	-	-	-	10.8	1	No	4058	2/16/08	-28.52
Blank	-	-	-	-	<1 (U)	1	No	4048	2/15/08	-
LCS_Lo	-	-	-	-	13.7	1	No	4049	2/15/08	-28.05
LCS_Hi	-	-	-	-	21.5	1	No	4050	2/15/08	-27.99
LCS acceptance range										<=> -28.50

Method	8200B	AM-24-AR_C	AM-24-DL_C
Units	ug/l	vs	%
Analyst	hg	cm	cm

If the area was insufficient, i.e. marked with a “U” flag, the del result will appear as a “-” (in some formats it comes out as an “NR”).

Surrogate

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1CB (Surrogate)	
Lab ID	Client ID
P0899999-01	MW-1
P0899999-02	MW-2

1CB (Surrogate)		CSIA (Carbon)							
Lab ID	Client ID	Dilution	Sample	Area (Vs)	PQL	Co-elution	Analysis	Date	Del (%)
P0899999-01	MW-1	1	3.35	1	No		4052	2/15/08	-29.99
P0899999-02	MW-2	100	5.06	1	No		4057	2/16/08	-29.65
P0899999-02	MW-2	1	4.90	1	No		4060	2/16/08	-30.03

A surrogate is injected into every field sample and every QC sample during analysis. The surrogate results are summarized in the surrogate table provided at the back of each CSIA report. The surrogate allows for a check of the ability of the CSIA system to measure the del of that surrogate accurately from the same sample and dilution as was used for any of the target analyte measurements. The surrogate is chosen to be something that would not be present in a field sample, but there is still the potential for corruption of the surrogate peak by interferences present in the sample.

P0899999-07	MW-7	1	3.26	1	No		4055	2/16/08	-29.55	
Dup (-03)	MW-3 (DF100)	100	3.68	1	No		4058	2/16/08	-29.98	
Blank		1	3.59	1	No		4048	2/15/08	-29.69	
LCS_Lo		1	3.59	1	No		4049	2/15/08	-29.92	
LCS_Hi		1	3.62	1	No		4050	2/15/08	-29.92	
Surrogate acceptance range								-29.38	<=>	-30.7

A Surrogate acceptance range given and the measured del should be within those limits, unless a co-elution is reported.

LCS_Hi	
Surrogate acceptance range	

Dilution

	Sample	
	Dilution	Sample
	1	3.3
	100	5

The most robust way to reduce signal strength is simple dilution, and that is the technique used at Microseeps.

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1CB (Surrogate)		CSIA (Carbon)						
Lab ID	Client ID	Sample Dilution	Area (µg)	PQL	Co-elution	Analysis	Date	Del (%)
P0899999-01	MW-1	1	3.35	1	No	4052	2/15/08	-29.99
P0899999-02	MW-2	100	5.06	1	No	4057	2/16/08	-29.65
P0899999-02	MW-2	1	4.90	1	No	4060	2/16/08	-30.03

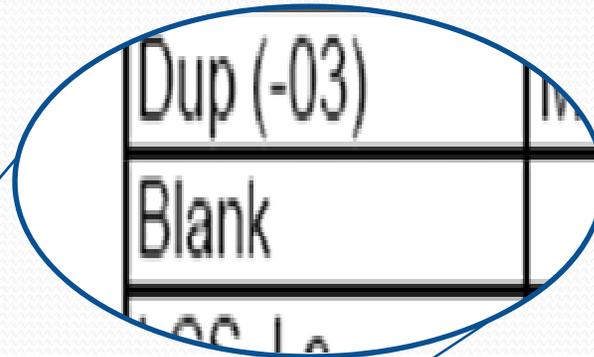
To be able to accurately measure the del of the individual components, it is necessary to reduce the signal strength of the more concentrated species. The most robust way to reduce signal strength is simple dilution, and that is the technique used at Microseeps. To measure the species in that same sample that are present at low concentrations, a less diluted or undiluted run may be required. As such it is not uncommon for a single field sample to be analyzed two or three times. By using the analysis number given with each result, the surrogate table can be used to see what dilution was analyzed to obtain each result.



Batch Quality Control

- Duplicate
- Blank
- Laboratory Control Samples
 - LCS_Lo
 - LCS_Hi
- Matrix Spikes
 - Matrix Spike Duplicates

Blank



The blank serves the typical role of proving that there is no contamination left from the previous run. While we are not measuring concentration, carry-over can pose a problem in CSIA because the del values of a particular analyte differs from sample to sample. If there is carry-over the measured del will reflect a mixture of the current sample and the previous one.

...carry-over can cause a problem in CSIA.

Ideally for each target analyte in the blank there is a U, but for the surrogate in the blank there is a strong signal and the expected del is measured for that surrogate. (The absence of target analytes is proven by the U's, and the surrogate response proves that if the target analytes were present, they would have been seen, so the U's are valid.)

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P0899999
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Vinyl Chloride		Concentration (ug/l)			CSIA (Carbon)					
Lab ID	Client ID	Sample	PQL	Del	Sample	PQL	Co-elution	Analysis	Date	Del (%)
P0899999-01	MW-1	<5 (U)	5	2/4/08	<1 (U)	1	No	4052	2/15/08	-
P0899999-02	MW-2	5 (U)	5	2/4/08	<1 (U)	1	No	4060	2/16/08	-
P0899999-03	MW-3	2000	200	2/5/08	11.3	1	No	4063	2/16/08	-26.49
P0899999-04	MW-4	9	5	2/4/08	3.6	1	No	4062	2/16/08	-28.19
P0899999-05	MW-5	5 (U)	5	2/5/08	<1 (U)	1	No	4053	2/16/08	-
P0899999-06	MW-6	<5 (U)	5	2/5/08	<1 (U)	1	No	4054	2/16/08	-
P0899999-07	MW-7	<5 (U)	5	2/5/08	<1 (U)	1	No	4055	2/16/08	-
Dup (-03)	MW-3 (DF100)	-	-	-	10.8	1	No	4058	2/16/08	-28.52
Blank	-	-	-	-	<1 (U)	1	No	4048	2/15/08	-
LCS: Lo	-	-	-	-	13.7	1	No	4049	2/15/08	-28.05
LCS: Hi	-	-	-	-	21.5	1	No	4050	2/15/08	-27.99
LCS acceptable range	-	-	-	-	-	-	-	27.50	<=>	-28.50
Method	8260B				AM-24-AR_C				AM-24-DL_C	
Units	ug/l				vs				%	
Analyst	hg				cm				cm	

Laboratory Control Samples

LCS_Lo
LCS_Hi
LCS acceptance range

To ensure quality, Laboratory Control Samples (LCS's) are constructed from laboratory grade DI water spiked with all of the analytes. The del values measured from these samples can be checked against the "LCS accepted value" and the results should lie within that range. These values were arrived at by repeated analysis of these constituents in laboratory derived samples, and details of that procedure are available in Microseep's SOP AM24.

It is important to note that an LCS acceptance range is given for the del of each compound. These ranges are measured through replicate analyses of the standard at various concentrations in water. The details are provided in the SOP AM-24. These ranges are very important and play a vital role in each of the three purposes of the LCS detailed on the following page..

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Vinyl Chloride		Concentration (ug/l)			CSIA (Carbon)					
Lab ID	Client ID	Sample	PQL	Date	Sample	PQL	Co-elution	Analysis	Date	Del (%)
P0899999-01	MW-1	<5 (U)	5	2/4/08	<1 (U)	1	No	4052	2/15/08	-
P0899999-02	MW-2	5	5	2/4/08	<1 (U)	1	No	4060	2/16/08	-
P0899999-03	MW-3	200	200	2/5/08	11.3	1	No	4063	2/16/08	-26.49
P0899999-04	MW-4	9	5	2/4/08	3.6	1	No	4062	2/16/08	-28.19
P0899999-05	MW-5	<5 (U)	5	2/5/08	<1 (U)	1	No	4053	2/16/08	-
P0899999-06	MW-6	<5 (U)	5	2/5/08	<1 (U)	1	No	4054	2/16/08	-
P0899999-07	MW-7	<5 (U)	5	2/5/08	<1 (U)	1	No	4055	2/16/08	-
P0899999-08	MW-8 (DF100)	-	-	-	10.8	1	No	4058	2/16/08	-28.52
Blank	-	-	-	-	<1 (U)	1	No	4048	2/15/08	-
LCS_Lo	-	-	-	-	13.7	1	No	4049	2/15/08	-28.05
LCS_Hi	-	-	-	-	21.5	1	No	4050	2/15/08	-27.99
LCS acceptance range	-	-	-	-	-	-	-	-27.50	<=>	-28.50
Units	8260B	ug/l			AM-24-AR_C				AM-24-DL_C	
Analyst		hg			cm				cm	

LCS purposes

1. Measure the del of each target analyte in a isotopically known sample.
This ensures that the measurements are accurate at the concentration in the LCS.
2. Measure the del in two samples that are isotopically identical but differ in concentration.
This ensures there is no significant concentration dependence to the del measurements.
3. Calculate the calibration factor for later use in diagnosing co-elution.
The contents of the LCS's are completely known, and there should be no co-elution in them. While this method is not intended to measure concentration, the area response, corrected for dilution, should be proportional to the concentration. That proportionality is used to insure that the peak area of a sample could all be attributed to the target analyte. If the peak area in a sample peak is larger than would be expected given the measured concentration, there is probably a co-elution. Co-elutions have been discussed in more detail previously.

LCS_Lo	
LCS_Hi	
LCS acceptance range	



Matrix Spikes

Matrix spikes and matrix spike duplicates are useful tools for validating concentration results.

Unfortunately, they are not meaningful in CSIA.

Several things have been done to make up for this.

Duplicate samples are analyzed more frequently.

Additionally, rather than just a single LCS, two LCS's are used.

- For accuracy, use the LCS_Hi
- For precision, use the LCS_Lo and the LCS_Hi
- For matrix effects, use the surrogate

Case Narrative

In the Case Narrative any exceptions are discussed, as is their potential effect upon the reported data. Microseeps makes every effort to issue the most valid reports possible, and to flag any suspect data that is reported. In no way is the case narrative intended to alarm the data user nor is it intended to be a list of excuses for the laboratory.

The Case Narrative explains any exceptions.

Rather, the case narrative is intended to be a succinct description of the analytical project where the data validity is assessed and any potential detractors from that validity are explained in terms of their cause and their effect upon the reported data. This is presented to empower the data user to be more confident about their data.

Case Narrative: The surrogate 1CB co-eluted with a matrix interferent in samples MW-3 and MW-4. This was easily diluted in the DF1 samples. However, in those dilutions this made the surrogate unusable. The surrogates worked well in the other samples.

LCS_Lo		1	3.59	1	No	4049	2/15/08	-29.92
LCS_Hi		1	3.62	1	No	4050	2/15/08	-29.92
Surrogate acceptance range						-29.38	<=>	-30.38
Method		AM-24-AR_C				AM-24-DL_C		
Units		Vs				‰		
Analyst		cm				cm		

Case Narrative: The surrogate 1CB co-eluted with a matrix interferent in samples MW-3 and MW-4. This was easily diluted in the DF1 samples. However, in those dilutions this made the surrogate unusable. The surrogates worked well in the other samples.



Other References

This concludes the discussion of the report you have received from Microseeps. Interpretation of what the del values mean for your site is another very important issue. While that is beyond the scope of this document, there are several excellent sources of information we would like to point out:

- “Monitored Natural Attenuation of MTBE as a Risk Management Option at Leaking Underground Storage Tank Sites.” 2005. USEPA, EPA/600/R-04/1790

It is focused upon MTBE, but it covers a lot of vital fundamentals that are applicable to CSIA in general.

- “Compound Specific Isotope Analysis: The Science, Technology and Selected Examples from the Literature with Application to Fuel Oxygenates and Chlorinated Solvents.” 2007. Available at <http://www.microseeps.com/pdf/csia.pdf>

This paper is a review of much of the available literature, starting from the fundamental basics and covering MTBE remediation, chlorinated solvent remediation, biodegradation and such other topics as CSIA and ISCO or CSIA and modeling.

- The USEPA, in cooperation with the IAEA of the UN, is preparing “A Consensus Guide for Assessing Biodegradation and Source Identification with Compound Specific Isotope Analysis (CSIA).” That document is planned for release in October of 2008. It was prepared by a team of renowned experts and covers a multitude of issues in great depth.



We are confident that you will find the report you have received to be a very useful tool, and that CSIA can be a powerful part of your remediation work. Please feel free to contact us not only about work that has been done or is ongoing, but also work that is planned. We would love to discuss your project goals and potential ways we can fill them.

