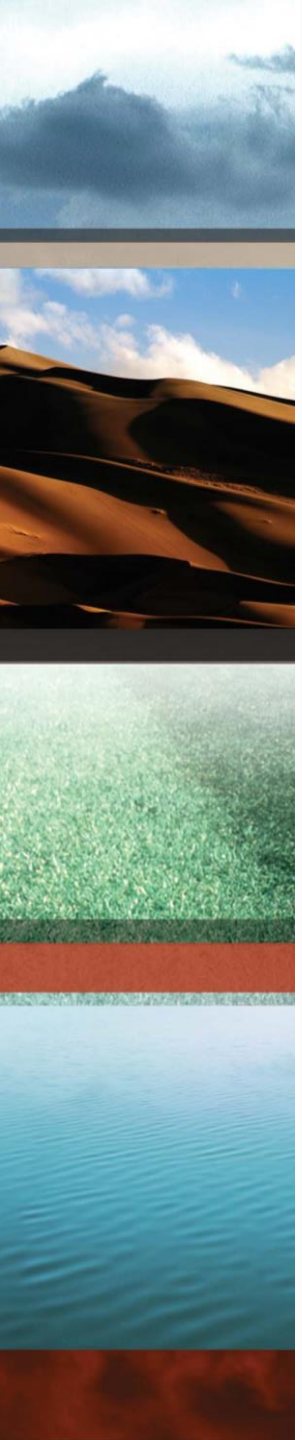
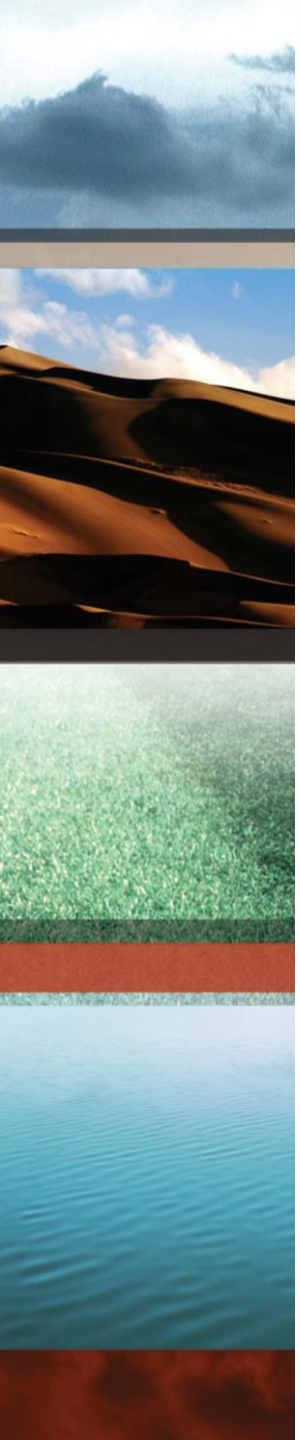
The New MDL Procedure How To's

Presented by:
Marcy Bolek - Alloway



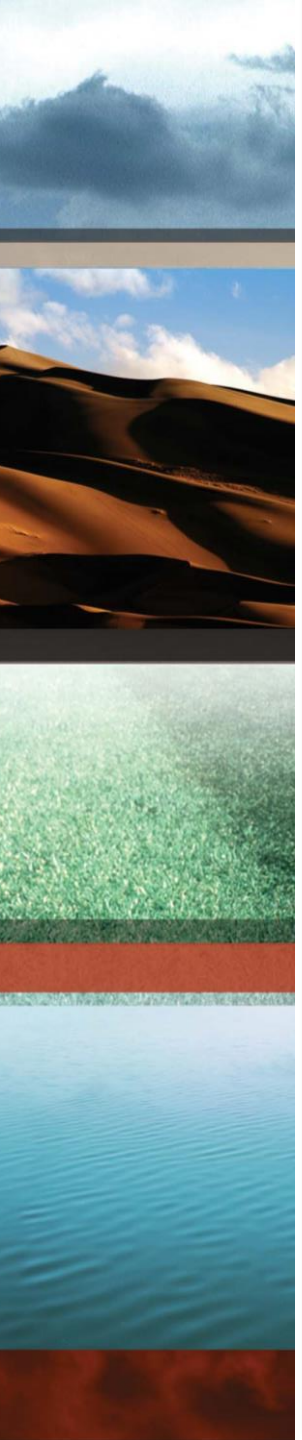
Proposed MDL Revision 2015 MUR

- How to obtain a copy of the proposed MDL revision?
- https://www.gpo.gov/fdsys/pkg/FR-2015-02-19/pdf/2015-02841.pdf
- Go to page 120 of the PDF document



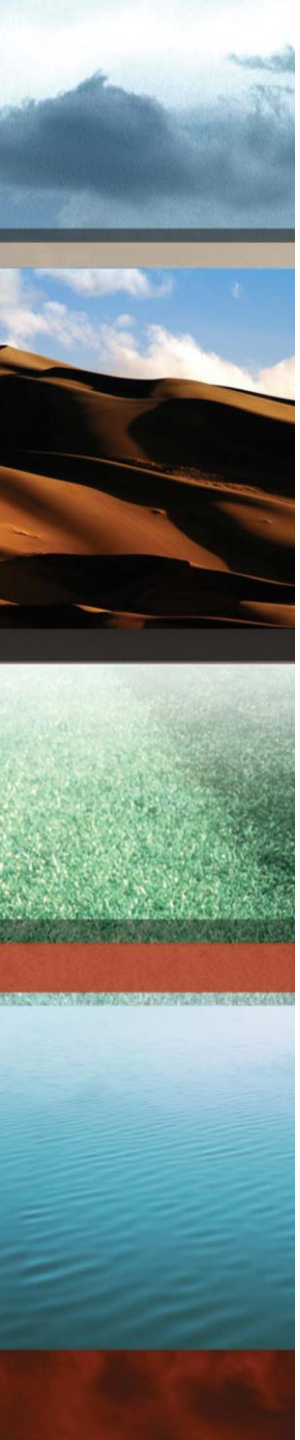
Main problems with the current definition of the MDL

- The current procedure for calculating the MDL (3.14 times the standard deviation of seven low level spiked blanks) assumes that the spiked blank results are centered around zero.
- If the spiked blank results aren't centered around zero, then the MDL will be too low and false positives will result.
- Realistically, results of spiked blanks are not centered around zero.



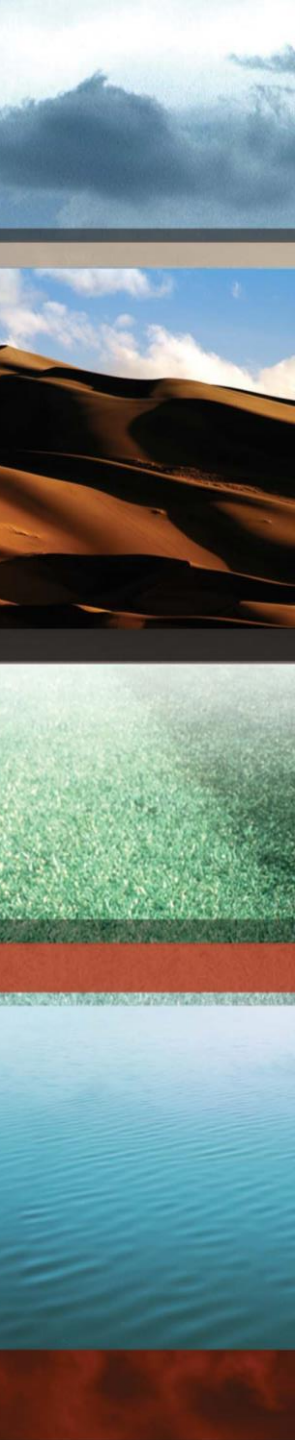
Main problems with the current definition of the MDL

- The current MDL procedure assumes that short term and long term variance are the same.
- In other words, the procedure assumes that the variability in instrument response over one batch of analyses is the same as the variability in instrument response over a longer time period.
- The current procedure also assumes that the response is the same for all instruments used to analyze a particular parameter.



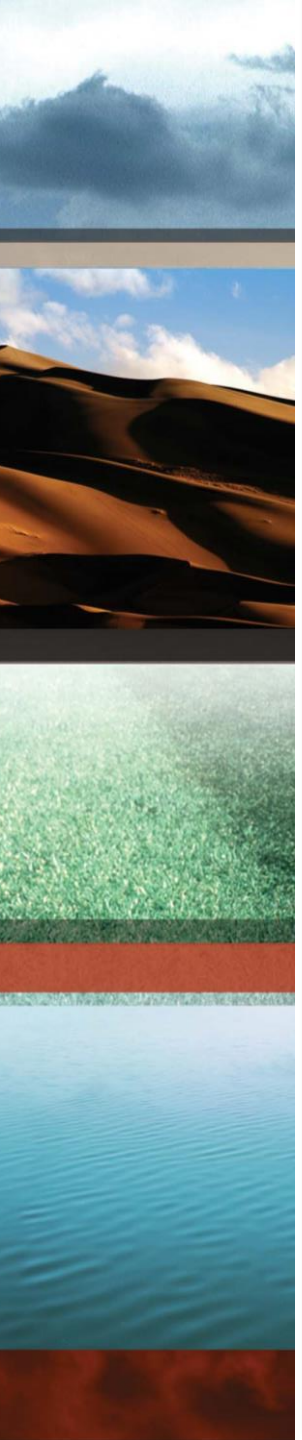
Main problems with the current definition of the MDL

- The current MDL procedure has no verification that the results obtained are reasonable.
  - Perform it once/year
  - Obtain a MDL concentration
  - Meets method requirements
  - Must be ok, right?



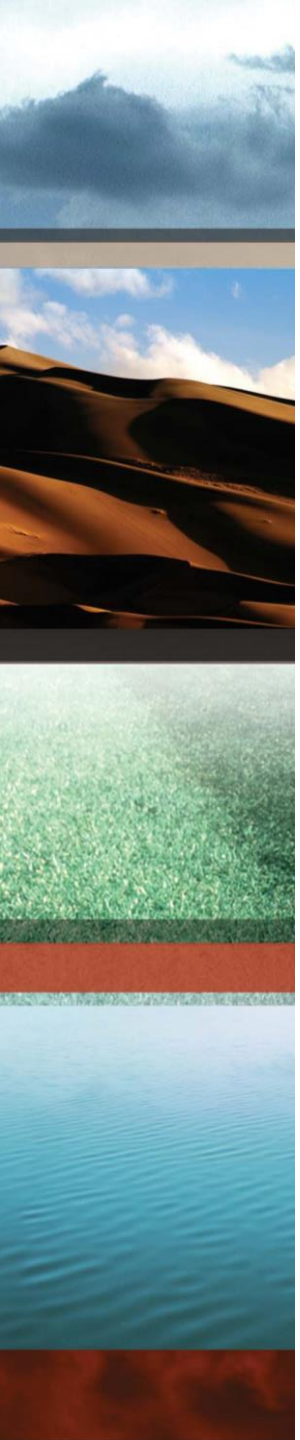
Main changes to the MDL proposed by EPA in the February 19, 2015 Federal Register

- The revised MDL procedure accounts for background contamination.
- In the revised MDL procedure, two MDLs are calculated —
  - One from seven low level spiked samples as in the current procedure
  - One from seven method blanks.
  - The MDL is then set as the **higher** of the two.



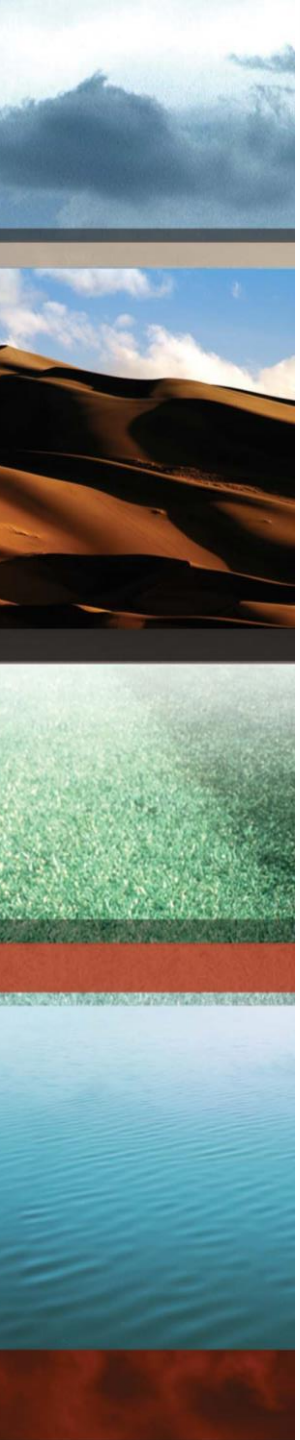
Main changes to the MDL proposed by EPA in the February 19, 2015 Federal Register

- The proposed revision to the MDL procedure requires that MDL samples be run in at least three separate preparation and analysis batches.
- In addition, if a laboratory uses multiple instruments, then it will be required to calculate the MDL using spiked samples and blank samples from all the instruments.
- This modification will make the MDL more representative of a laboratory's actual capability.



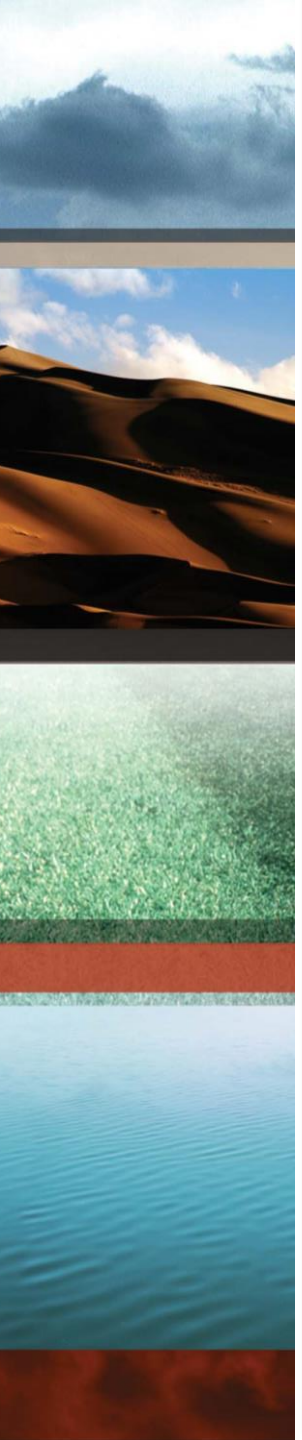
Main changes to the MDL proposed by EPA in the February 19, 2015 Federal Register (Cont.)

- The revised MDL procedure requires ongoing quarterly MDL verification and annual recalculation.
- Now MDL's are analyzed 1/year under the most ideal circumstances
  - Immediately after the instrument has been serviced
  - After an annual routine maintenance
- Possibly resulting in artificially low MDLs.
- Quarterly evaluation will determine if the MDL has significantly drifted during the year, and also help verify that the results obtained are reasonable.



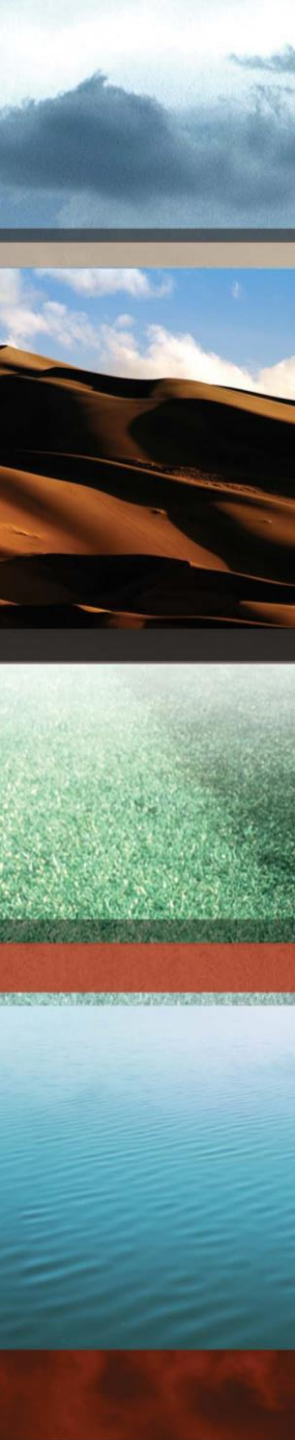
New MDL Determination Procedure

- Estimate the Initial MDL using one of the following:
  - The mean plus three times the standard deviation of a set of method blanks.
  - The concentration value that corresponds to an instrument signal/noise in the range of 3 to 5.
  - The concentration equivalent of three times the standard deviation of replicate instrumental measurements of spiked blanks.



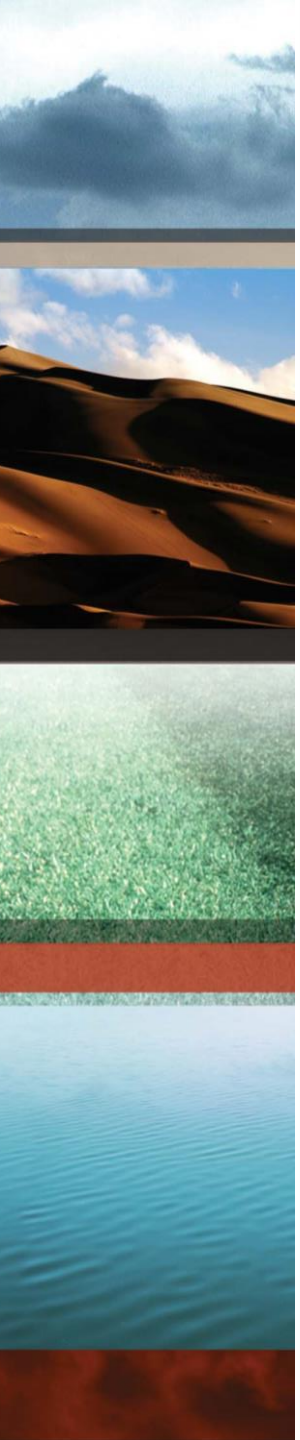
New MDL Determination Procedure

- Estimate the Initial MDL using one of the following (Cont.):
  - That region of the standard curve where there is a significant change in sensitivity, i.e., a break in the slope of the standard curve.
  - Instrumental limitations.
  - Previously determined MDL.
  - It is recognized that the experience of the analyst is important to this process. However, the analyst should include some or all of the above considerations in the initial estimate of the MDL.



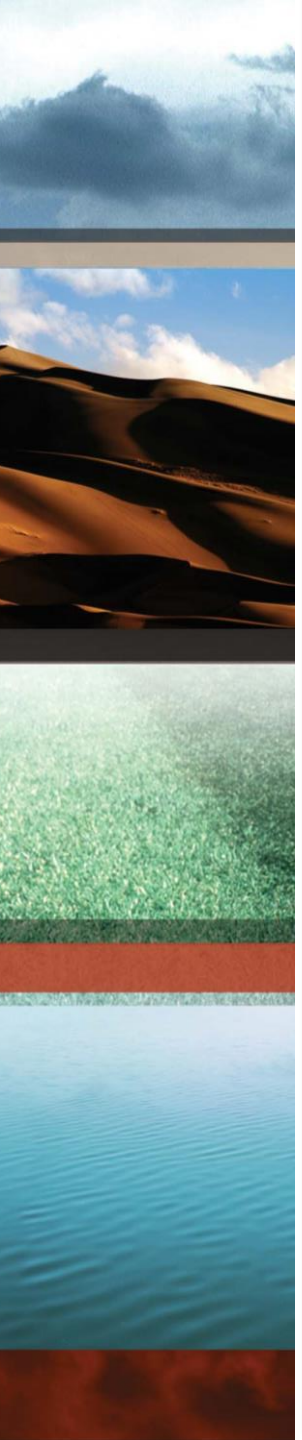
New MDL Determination Procedure

- Select a spiking level
- Typically 2–10 times the estimated MDL
- Spiking levels in excess of 10 times the estimated detection limit may be required for analytes with very poor recovery.



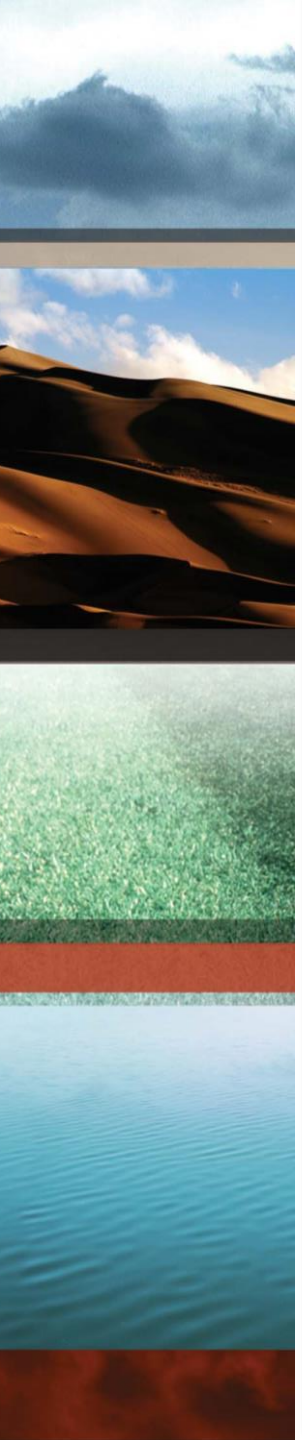
New MDL Determination Procedure

- Process a minimum of 7 spiked blank samples and 7 method blank samples through all steps of the method, including any sample preservation.
- Both preparation and analysis of these samples must include at least three batches on three separate calendar dates.
- Existing data may be used if compliant with the requirements for at least 3 batches and generated within the last 2 years.



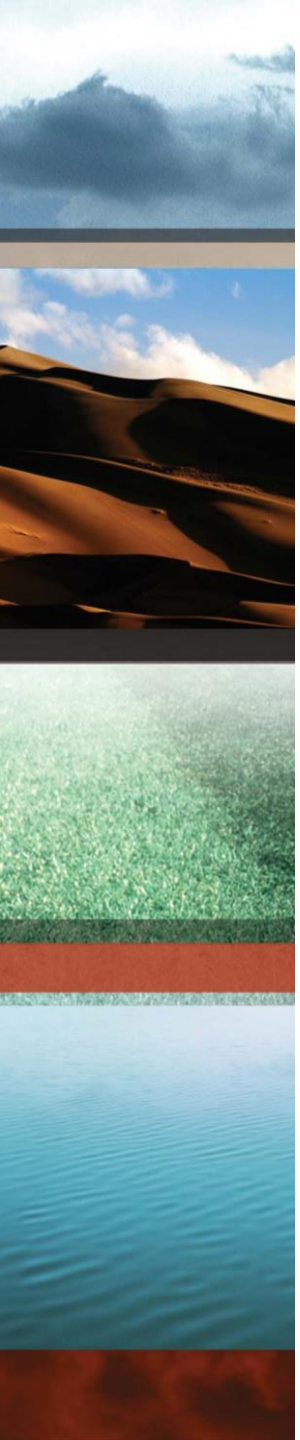
New MDL Determination Procedure

- If there are multiple instruments that will be assigned the same MDL, then the samples must be distributed across all of the instruments.
- A minimum of two spiked samples and two method blank samples prepared and analyzed on different calendar dates is required for each instrument.



New MDL Determination Procedure

- Evaluate the spiking level:
- If any result for any individual analyte from the spiked blank samples does not meet the method qualitative identification criteria or,
- Does not provide a numerical result greater than zero,
- Then repeat the spikes at a higher concentration.



New MDL Determination Procedure

- Compute the MDL_S (MDL based on spiked blanks) as follows:

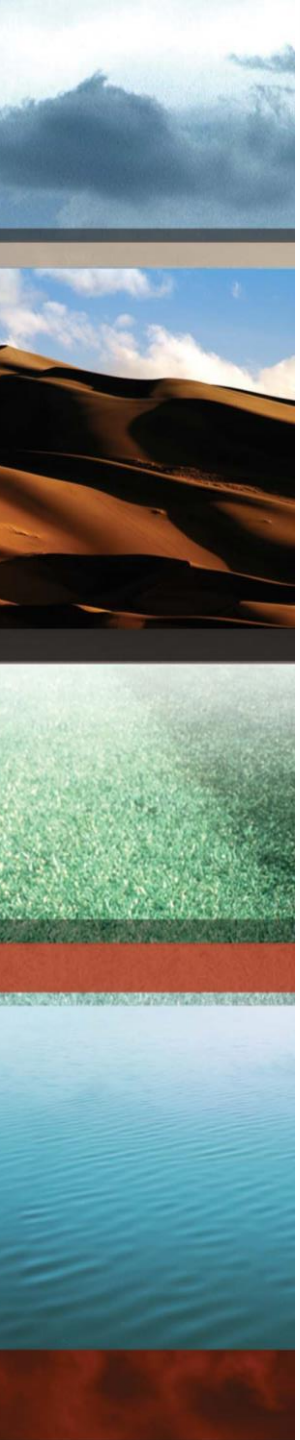
$$MDL_S = t(n-1, 1-\alpha=0.99)\, S_S$$

Where:

MDLs = the method detection limit based on spiked blanks

t(n-1, 1-α=0.99) = the Student's t-value appropriate for the single tailed 99th percentile t statistic and a standard deviation estimate with n-1 degrees of freedom.

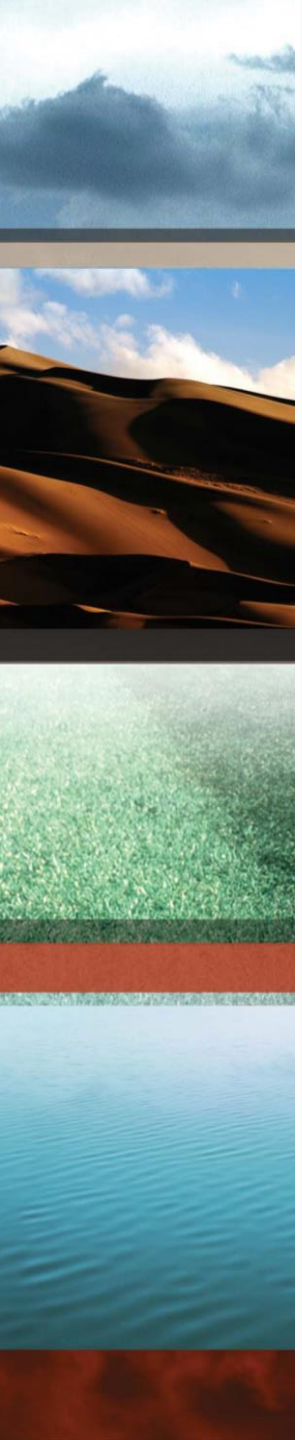
S_S = sample standard deviation of the replicate spiked blank sample analyses.



New MDL Determination Procedure

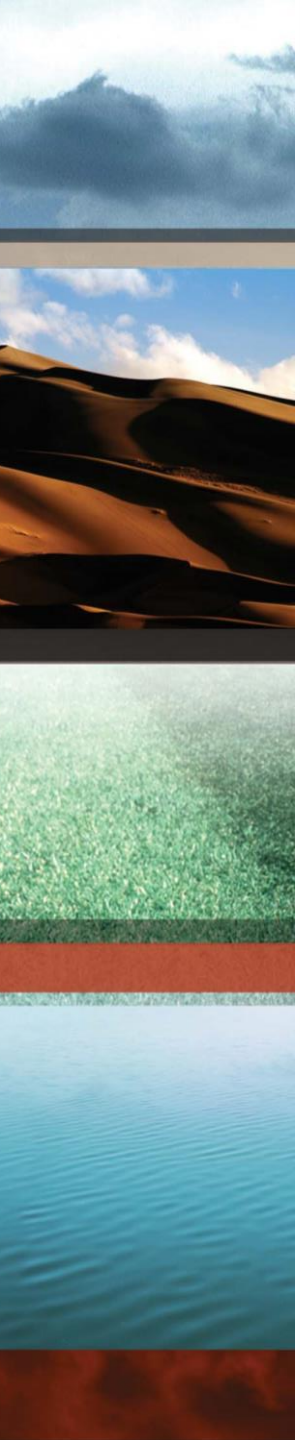
The values for student's t value at 99% confidence interval are below

Data Points	Degrees of Freedom	t Value
7	6	3.143
8	7	2.998
9	8	2.836
10	9	2.821
16	15	2.802
21	20	2.526
31	30	2.457



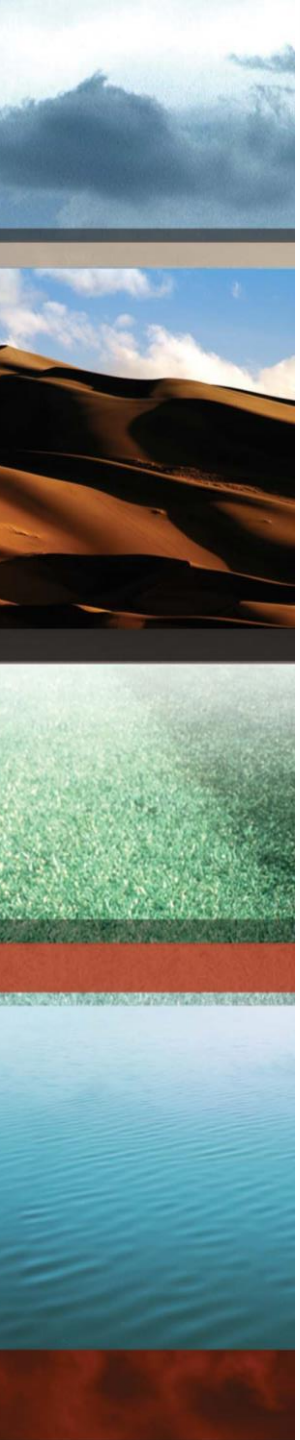
New MDL Determination Procedure

- Calculating T-Value in Excel
  - =T.INV(p,df)
  - p = Probability
  - df = The degrees of freedom
  - “=T.INV(0.99,6)” will give the answer 3.143



New MDL Determination Procedure

- Calculating S in Excel – Standard Deviation, sample
- =STDEV.S(Cell Range)
- Ex: =STDEV.S(C2:C8)

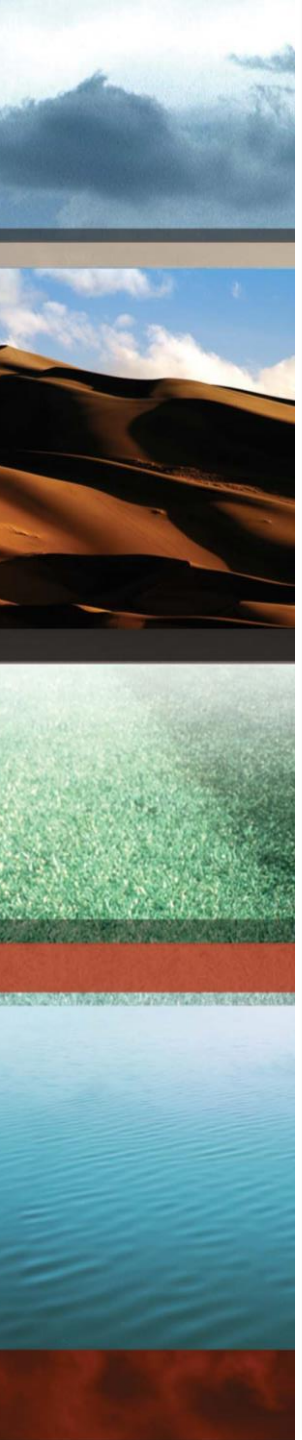


New MDL Determination Procedure

- **Compute the MDL_b (MDL based on method blanks) as follows:**

A. If none of the method blanks give numerical results for an individual analyte, the MDL_b does not apply.

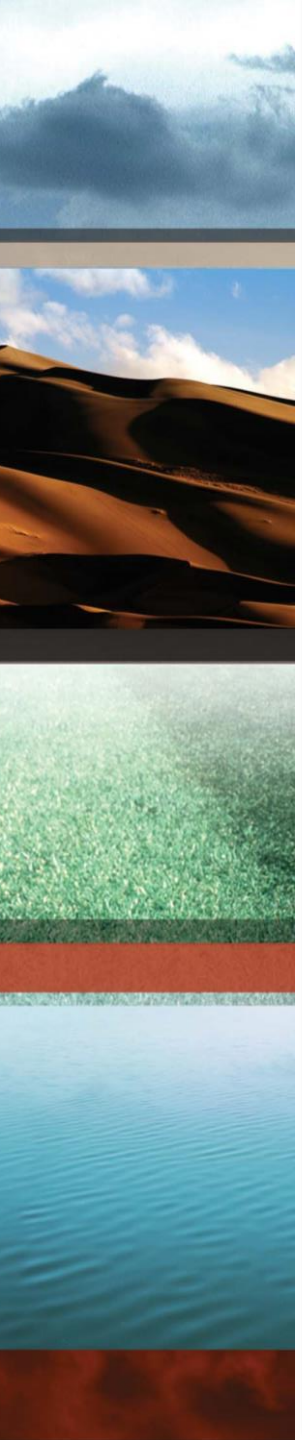
➢A numerical result includes both positive and negative results, including results below the current MDL.



New MDL Determination Procedure

- **Compute the MDL_b (MDL based on method blanks) as follows (Cont.):**

B. If some (but not all) of the method blanks for an individual analyte give numerical results, set the MDL_b equal to the highest method blank result.

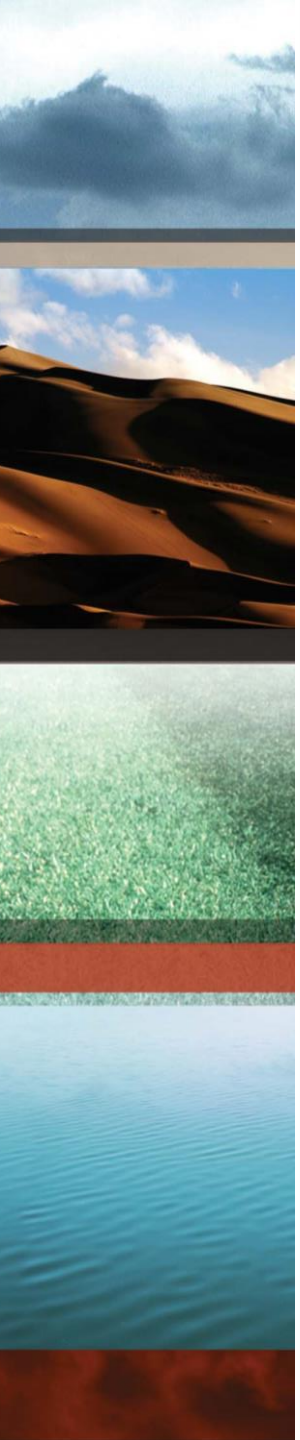


New MDL Determination Procedure

- **Compute the MDL_b (MDL based on method blanks) as follows (Cont.):**

C. If more than 100 method blanks are available, set MDL_b to the level that is no less than the 99th percentile of the blank results.

- For ‘‘n’’ method blanks where n ≥ 100, sort the method blanks in rank order. The (n×0.99) ranked method blank result (round to the nearest whole number) is the MDL_b . For example, to find MDL_b from a set of 164 method blanks where the highest ranked method blank results are . . . 1.5, 1.7, 1.9, 5.0, and 10, then 164×0.99 = 162.36 which rounds to the 162nd method blank result. Therefore, MDL_b is 1.9 for n = 164 (10 is the 164^{th} result, 5.0 is the 163^{rd} result, and 1.9 is the 162^{nd} result).



New MDL Determination Procedure

- **Compute the MDL_b (MDL based on method blanks) as follows (Cont.):**

D. If all of the method blanks for an individual analyte give numerical results, calculate the MDL_b as:

$$MDL_b = \bar{x} + t(n-1, 1-\alpha=0.99)\, S_b$$

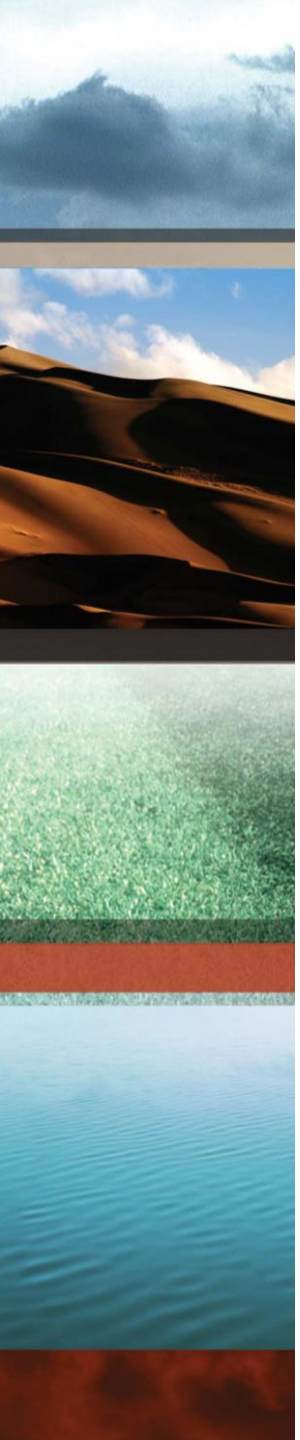
Where:

MDL_b = the MDL based on method blanks

$\bar{x}$ = mean of the method blank results

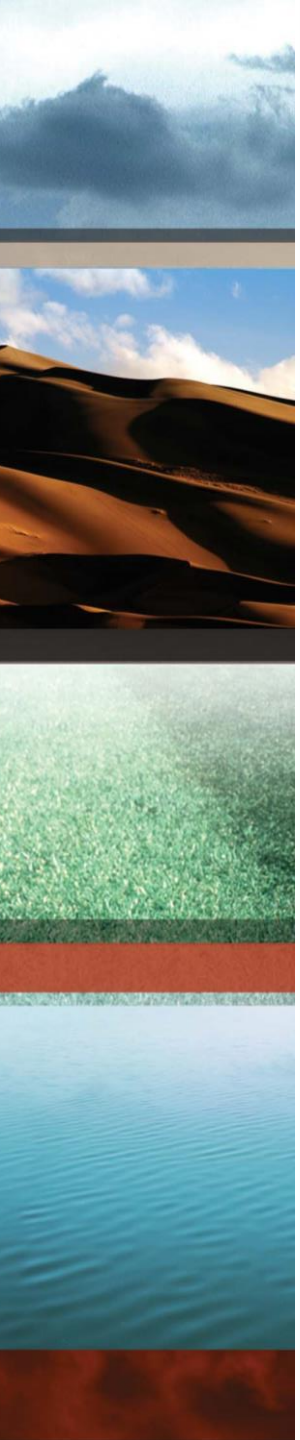
$t(n-1, 1-\alpha=0.99)$ = the Student's t-value appropriate for the single tailed 99^{th} percentile t statistic and a standard deviation estimate with n-1 degrees of freedom.

S_b = sample standard deviation of the replicate blank sample analyses.



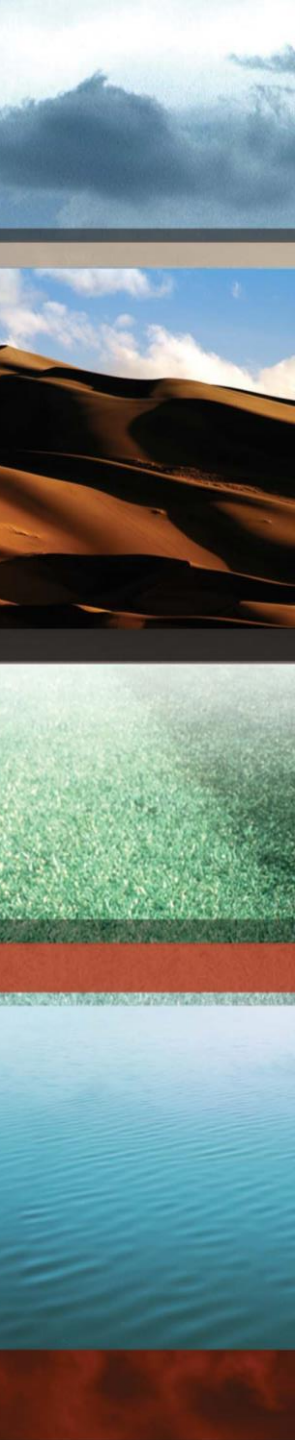
New MDL Determination Procedure

- Set the greater of MDL_s or MDL_b as the initial MDL.



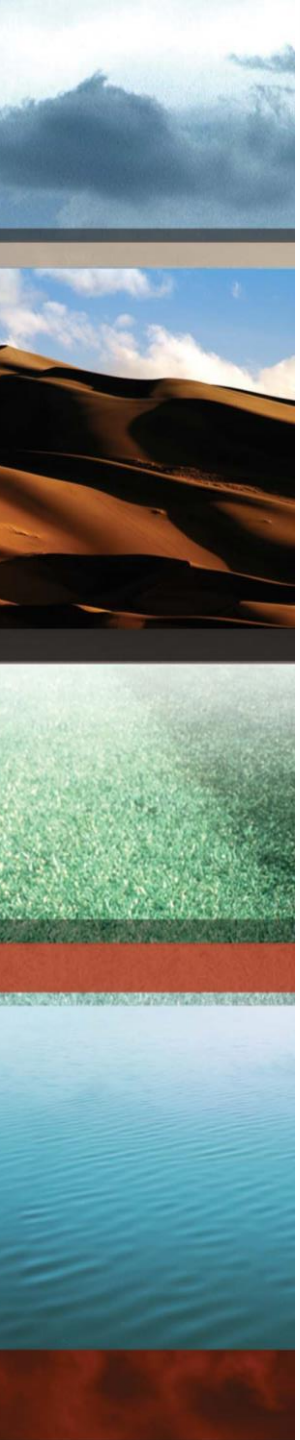
New MDL Determination Procedure

- **Ongoing Data Collection**
  - During any quarter in which samples are being analyzed, prepare and analyze a minimum of two spiked blanks on each instrument, in separate batches if available, using the same spiking concentration used in Section 2.
  - If any analytes are repeatedly not detected in the quarterly spike sample analysis, this is an indication that the spiking level is not high enough and should be adjusted upward.



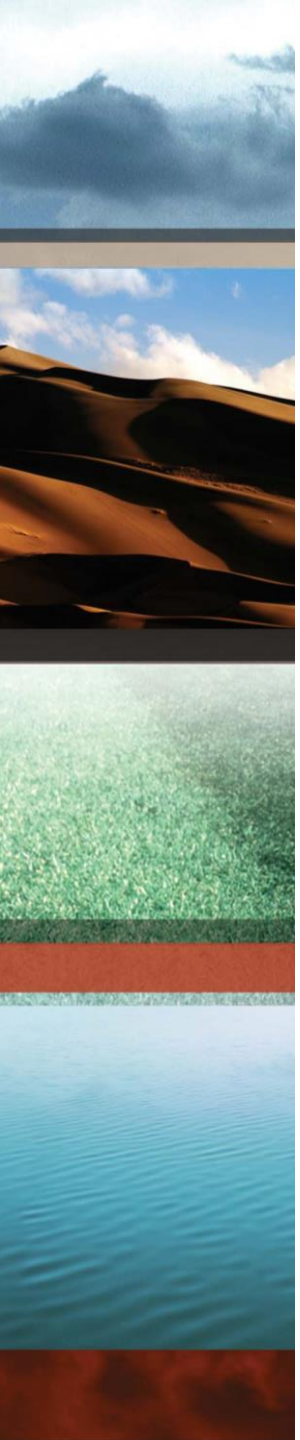
New MDL Determination Procedure

- **Ongoing Data Collection (Cont.)**
  - Ensure that at least 7 spiked blanks and 7 method blanks are completed for the annual verification.
  - At least once per year, re-evaluate the spiking level.



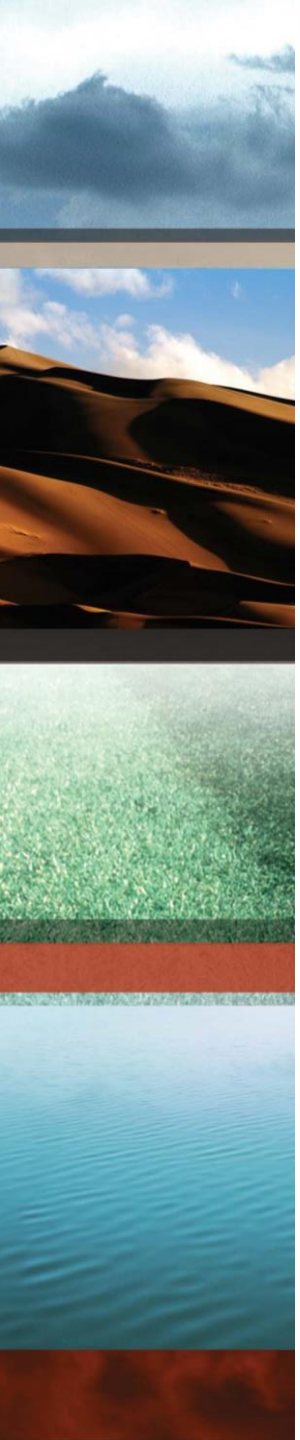
New MDL Determination Procedure

- **Ongoing Data Collection (Cont.)**
  - If more than 5% of the spiked blanks do not return positive numerical results that meet all method qualitative identification criteria, then the spiking level must be increased and,
  - The initial MDL must be re-determined following the procedure in Section 2.



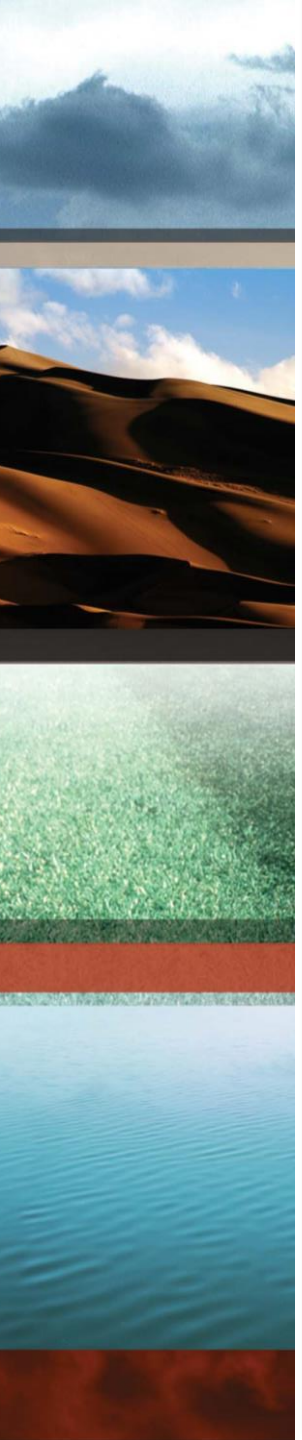
New MDL Determination Procedure

- If the method is altered in a way that can be reasonably expected to change the detection limit then,
- Re-determine the initial MDL according to Section 2, and the ongoing data collection restarted.



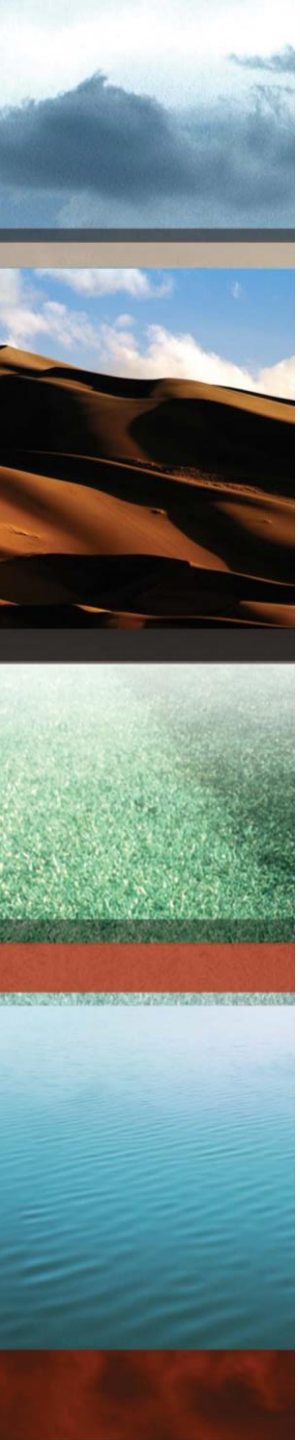
New MDL Determination Procedure

- **Ongoing Annual Verification**
  - At least once per year, re-calculate MDL_s and MDL_b from the collected spiked blank and method blank results using the equations in section 2.
  - Include data generated within the last 2 years, but only data with the same spiking level.
  - Include the initial MDL spiked blanks if within two years.



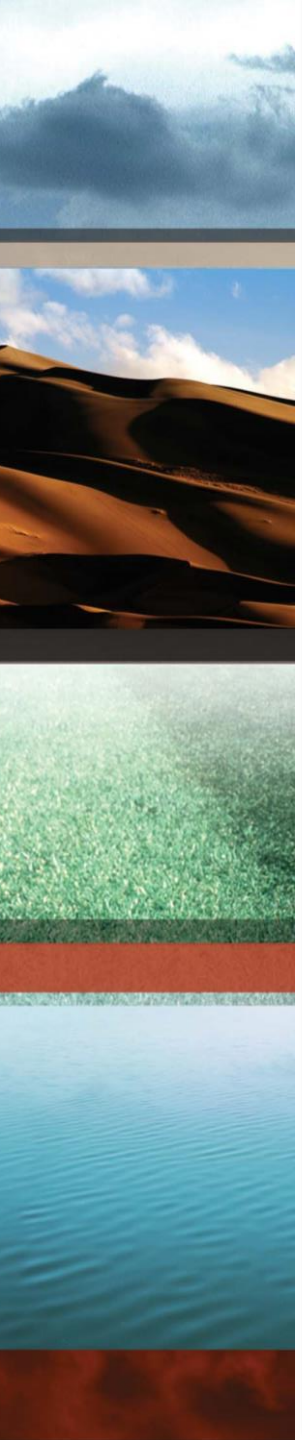
New MDL Determination Procedure

- **Ongoing Annual Verification (Cont.)**
  - Only use data associated with acceptable calibrations and batch QC.
  - Include all routine data, with the exception of batches that are rejected and the associated samples reanalyzed.
  - If the method has been altered in a way that can be reasonably expected to change the detection limit, use only data collected after the change.



New MDL Determination Procedure

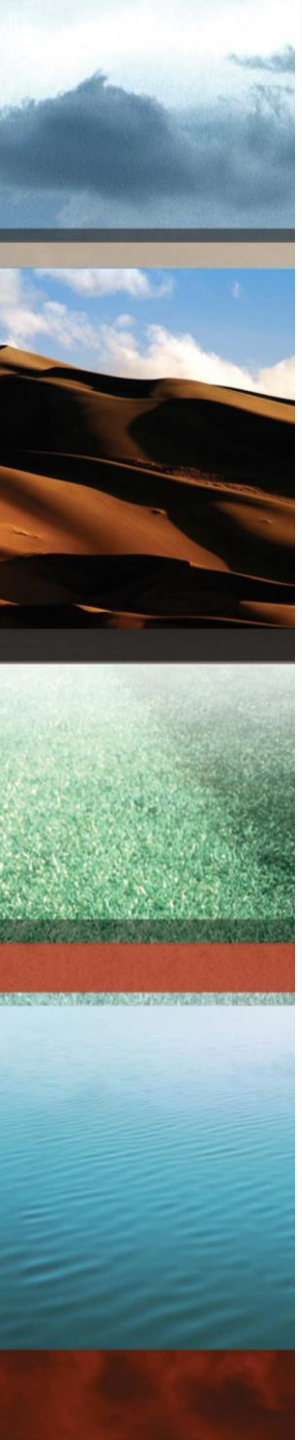
- **Ongoing Annual Verification (Cont.)**
  - The verified MDL is the greater of the MDL_s or MDL_b.
  - If the verified MDL is within a factor of 3 of the existing MDL, and fewer than 3% of the method blank results (for the individual analyte) have numerical results above the existing MDL, then the existing MDL may optionally be left unchanged.
  - Otherwise, adjust the MDL to the new verification MDL.



New and Old MDL Examples

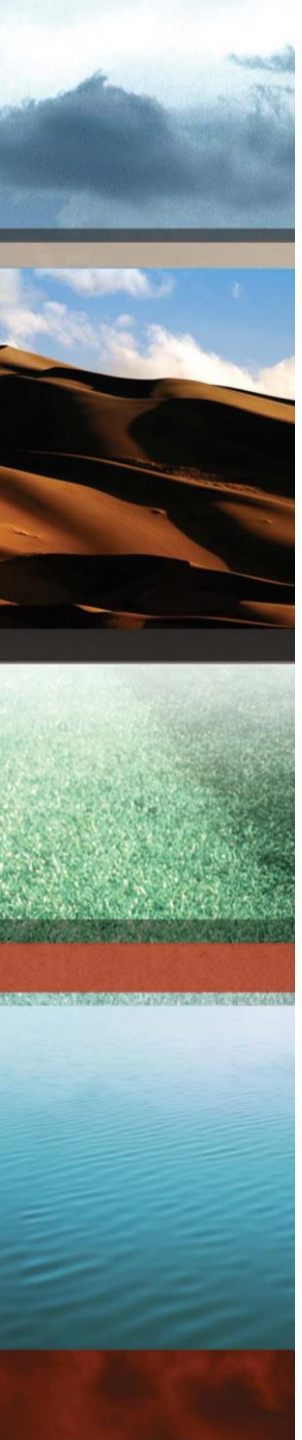
Data	Result	Blank
Point	ug/L	ug/L
1	1.38	0
2	1.39	0
3	1.45	0
4	1.35	0
5	1.28	0
6	1.35	0
7	1.42	0
S_s =	0.055032	
t=	3.142668	
MDL_s =	t x S_s	
MDL_s =	3.142668 x 0.055032	
MDL_s =	0.172949	
MDL_b =	0	
MDL =	0.172949	

Data	Result	
Point	ug/L	
1	1.38	
2	1.39	
3	1.45	
4	1.35	
5	1.28	
6	1.35	
7	1.42	
S_s =	0.055032	
t=	3.142668	
MDL_s =	t x S_s	
MDL_s =	3.142668 x 0.055032	
MDL_s =	0.172949	



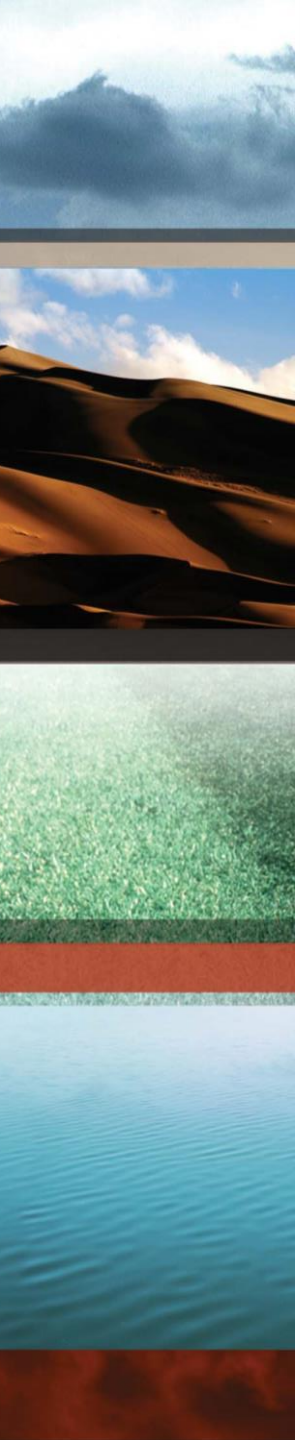
New and Old MDL Examples

Data Point	Result ug/L			Blank ug/L
1	1.38			0.62
2	1.39			0.21
3	1.45			0.24
4	1.35			0.51
5	1.28			0
6	1.35			0
7	1.42			0
S_s =	0.055032458		S_b =	
t=	3.142668403		t=	
MDL_s =	t x S_s		MDL_b =	
MDL_s =	3.142668 x 0.055032		MDL_b =	
MDL_s =	0.172948767		MDL_b =	0.62
MDL =	0.62			



New and Old MDL Examples

Data Point	Result ug/L			Blank ug/L	
1	1.38			0.62	
2	1.39			0.21	
3	1.45			0.24	
4	1.35			0.51	
5	1.28			0.51	
6	1.35			0.35	
7	1.42			0.42	
S_s =	0.055032		S_b =	0.150934	
t=	3.142668		t=	3.142668	
MDL_s =	t x S_s		MDL_b =	t x S_b	
MDL_s =	3.142668 x 0.055032		MDL_b =	3.142668 x 0.150934	
MDL_s =	0.172949		MDL_b =	0.474334	
MDL =	0.474334				



New and Old MDL Examples

Data Point	Result ug/L			Blank ug/L	
1	1.38			-0.58	
2	1.39			0.72	
3	1.45			-0.23	
4	1.35			0.56	
5	1.28			-0.39	
6	1.35			0.45	
7	1.42			0.65	
S_s =	0.055032		S_b =	0.547644	
t=	3.142668		t=	3.142668	
MDL_s =	t x S_s		MDL_b =	t x S_b	
MDL_s =	3.142668 x 0.055032		MDL_b =	3.142668 x 0.0.547644	
MDL_s =	0.172949		MDL_b =	1.721064	
MDL =	1.721064				