Capturing the Flag – Leveraging Laboratory Measurements of Uncertainty to Accelerate Data Usability

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Overview

- Sampling and analysis introduce uncertainty in all environmental assessments.
- Understanding and reporting uncertainty can increase confidence in data and allow for better decision-making.
- Standardized and cost-effective methods to calculate uncertainty are needed for environmental programs.

Confidence in Test Results

Capable and accountable environmental laboratories are increasingly being asked to calculate the measure of confidence that can be placed on their test results (QUAM 2012).

Benefit to Decision Making

Reporting the measurement uncertainty associated with laboratory test results allows the data user to compare them both to specific regulatory limits (i.e. risk level, action limit, MCL, permitting limits).

Sources of Uncertainty

Environmental Programs and Projects:

- Analytical and sampling processes contribute to the uncertainty in the result.
  - Sampling Sources of Uncertainty:

    Matrix, Frequency, Depth, Field Replicates, Spikes, Splits
  - Laboratory Sources of Uncertainty:

    Sample Preparation, Instrument Calibration, Standard Preparation & Equivalency
- Uncertainty can only be estimated if there is an understanding of both processes.

Project Management's Role

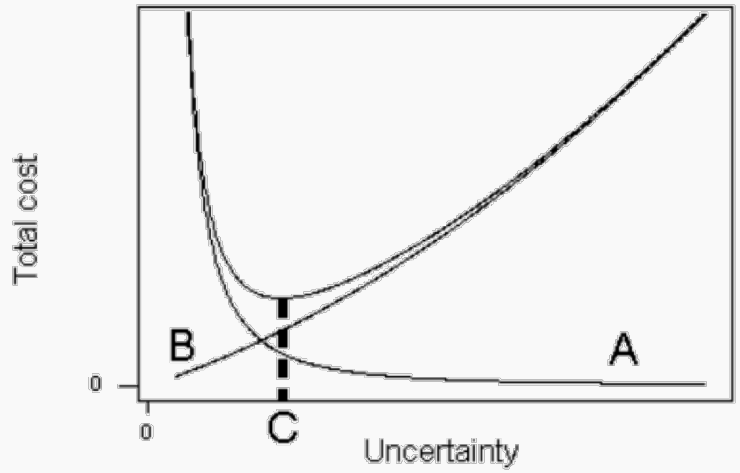
- Understand the sources of uncertainty.
- Identify objectives and devise a strategy to estimate uncertainty.
- Coordinate samplers and analysts.
- Understand regulatory guidance on how estimates of uncertainty are to be acted upon, to ensure the reliability of the decisions based upon the measurements.

Data Usability

The usability of data to support project decisions requires balancing the project sampling and analysis costs with the benefits of uncertainty minimization.

Cost of Decisions

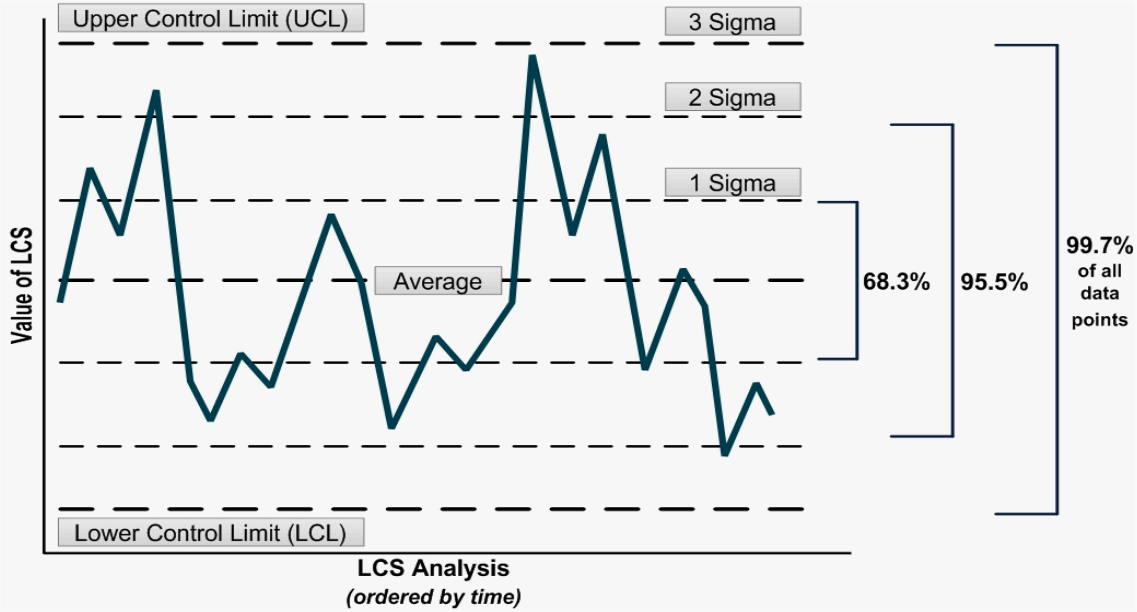
- The true cost of a decision is the sum of the measurement costs and the excess costs of incorrect decisions.
- This sum has a minimum value at some particular level of uncertainty and this uncertainty is the definition of fitness for purpose.



Line A: Cost of measurement
Line B: Cost of incorrect decisions
Point C: Uncertainty that is fit for this purpose

Example of Uncertainty Measurement

Quality Control Chart of a Laboratory Control Sample (LCS)



Values that do not fall within the control limits are rejected.

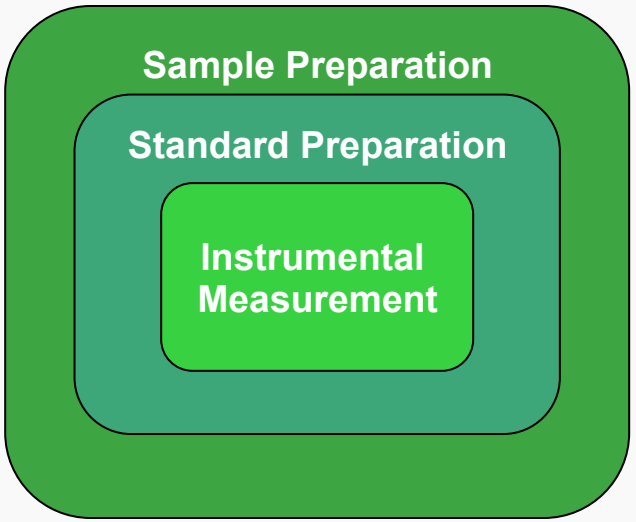
Measurement Uncertainty Categories

American Association of Laboratory Accreditation (A2LA) Policy 103

I. Qualitative / semi-quantitative tests with no uncertainty budget.
II. Test methods that specify limits to major sources of uncertainty.
III. Test methods based on published regulatory or consensus methods.
IV. Test methods with the major components of uncertainty identified and a reasonable estimate of measurement uncertainty.
V. Test methods with all sources of uncertainty identified and detailed measurement uncertainty budgets.

Nested Hierarchical Approach

- Includes only variables that most significantly contribute to uncertainty.
- Each component can be linked to traditional quality indicators.
- Multiple variables and multiple analyses used in statistical calculation.



Considerations for Estimating Uncertainty

- Specify level of confidence.
- Standardize components that significantly affect uncertainty around existing quality indicators.
- Develop an uncertainty budget based on project objectives.
- Obtain a number of measurements for each variable selected.
- Apply “bounds” to sample data.

Electronic Data Review

- Environmental laboratories may be required to report measurement uncertainty in the future.
- Electronic data review tools could assess:
  - Measurement uncertainty
  - Traditional quality control parameters

Conclusion

- Understanding and reporting uncertainty can increase confidence in data and allow for better decision-making.
- Program objectives and potential data usability should drive:
  - Goals for reducing uncertainty levels
  - Method for calculating measurement uncertainty (e.g., nested hierarchical approach) and variables to consider

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