CALA Guide to Current Sampling Practices

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Prepared for CALA by

Peter Fowlie

Cornerstone Science

pfowlie@cogeco.ca

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Scope of this Current Sampling Practices Guide

This guide has been developed to provide anyone involved in environmental or many other types of sampling with sufficient information in the form of existing best practice examples, to plan and carry out scientifically defensible sample collection for submission to a laboratory for analysis.

The intent is to show what documentation is currently available on the subject of what happens between the time that a sampler (an individual who does sampling) receives instructions to visit a sampling target (portion of material, at a particular time, that the sample is intended to represent) and when the sample arrives at the laboratory for testing.

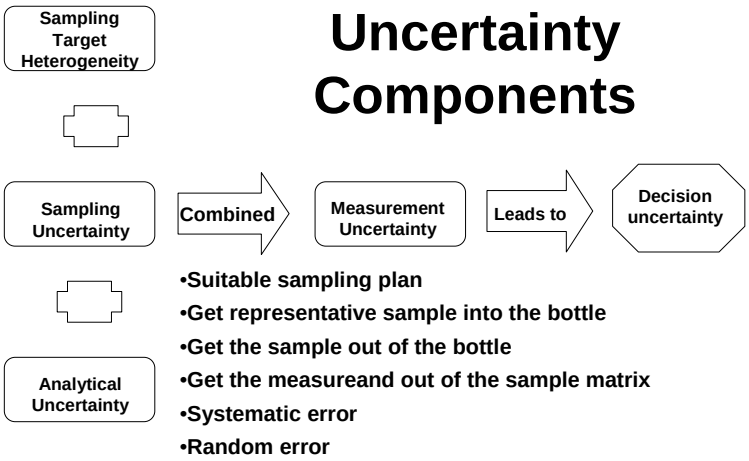
The intent is not for CALA to endorse, recommend or mandate particular sampling instructions, rather to show what the body of knowledge on the subject is currently.

With this information, and other documents that will arise, we hope that users of the information can identify areas where:

- There is lots of useful information available for people to use
- There is a lack of useful information
- Where that information might conflict between jurisdictions.

CALA intends this to be a live document that generates conversation, questions and a path to better knowledge of the sampling process and how it effects decisions made on the resulting data.

Error and uncertainty have many components that include heterogeneity of the Sampling Target, the sampling process and the analytical test. This document deals primarily with activities that take place before the test sample is received by the laboratory.



This document does not cover the topic of accreditation of sampling. Should readers wish to obtain more information on accreditation of sampling the following entities address accreditation of sampling. More information is available from the NELAC website which covers:

- ACLASS, ANSI-ASQ National Accreditation Board
- American Association for Laboratory Accreditation (A2LA)
- Laboratory Accreditation Bureau (L-A-B)
- Perry Johnson Laboratory Accreditation, Inc. (PJLA)

http://www.nelac-institute.org/howto-fsmo-nefap.php

Also see information provided by the Irish National Accreditation Board.

http://www.cala.ca/sampling/3_2013_Sampling_ISO_Accreditation.pdf

1.0 Introduction and General Sampling Considerations

1.1 The Role of Sampling and Monitoring

Sampling is typically required for both monitoring as well as for research purposes.
Sampling data may be used to monitor air and water effluents or to characterize various environmental media (air, water, soil, biota) for pollutant levels. It may also be used to comply with regulatory requirements, detect accidental releases, identify trends, or develop an inventory or database of pollutant levels.

What do a lot of the major accreditation and standards organizations" of the day say about sampling?

1.2 What does CALA say about Sampling

Neither CALA nor the ISO Standards say exactly how you should carry out sampling activities. Rather they provide a list of questions and requirements and ask the laboratory or the sampler how they intend to meet these requirements. Here are excerpts from two CALA rating guides used by assessors:

- CALA A02 – Assessment Rating Guide
- CALA A03 – Rating Guide Appendix.

CALA A02 – Assessment Rating Guide

B.06	5.7 Sampling	
ITEM	**CLAUSE**	**REQUIREMENT**
01	Procedures and Plan 5.7.1	Verify that procedures for sampling are available at the location where required, and include: • a sampling plan (based on appropriate statistical methods, wherever reasonable); • factors to be controlled to verify the validity of the results; • selection of samples; • withdrawal and preparation of samples.
02	Deviations 5.7.2	Verify that customer-requested deviations from the sampling plan are documented and communicated to the appropriate personnel.
03	Records 5.7.3	Verify that the laboratory has procedures for recording sampling data and operations; records to include: • sampling procedure; • sampler identification; • sampling location; • basis for sampling procedure statistics, if appropriate.
B.07	**5.8 Handling of Test and Calibration Items**	
01	Procedures 5.8.1, 5.8.4	Document procedures for test and/or calibration item management: • transportation; • receipt; • handling and preparation; • protection; • storage; • retention and/or disposal.
02	Identification 5.8.2	Verify that the laboratory has a system for identifying test and/or calibration items
03	Deficiencies 5.8.3	Verify that any abnormalities and deficiencies upon item receipt are recorded; if in doubt about suitability of item, verify that that customer is contacted and instructions are recorded.
04	Facilities 5.8.4	Verify that the laboratory has appropriate facilities to maintain item integrity, and the protection of secured items.
05	Environmental Conditions 5.8.4	Verify that required environmental conditions for items are maintained, monitored and recorded, as appropriate.
06	Handling Instructions 5.8.4	Verify that any handling instructions provided with the test and/or calibration item are followed.

CALA A03 – Rating Guide Appendix

04		SAMPLING
01	5.7	Sample History Verify that sample history requirements are: 1) appropriate; 2) documented and available where required; and 3) implemented; e.g., • field filtration; • chemical preservation; • sample containers; • storage conditions; • holding time.
02	5.7	Sampling and Sub-sampling Verify that sampling plans for samples are based on appropriate statistical methods and that the sampling process addresses the factors to be controlled to ensure the validity of the results; i.e., • Sampling/sub-sampling methods are available and followed; • Sampling plans are statistically based; • Appropriate drying temperature is used (for solid matrices); • Dust loss and cross-contamination are minimized (for solid matrices);
		Sampling and Sub-sampling (cont'd) • Sample size reduction generates a representative portion for subsequent work; • Uncertainty of sample size reduction steps is known through the introduction of random duplicates; • Field sampling generates representative samples, and duplicates are routinely taken.

1.3 What does ISO / IEC Standard 17025 say about Sampling

The following text was taken from ISO / IEC Standard 17025 :

5.7 Sampling
5.7.1 The laboratory shall have a sampling plan and procedures for sampling when it carries out sampling of substances, materials or products for subsequent testing or calibration. The sampling plan as well as the sampling procedure shall be available at the location where sampling is undertaken. Sampling plans shall, whenever reasonable, be based on appropriate statistical methods. The sampling process shall address the factors to be controlled to ensure the validity of the test and calibration results.

NOTE 1 Sampling is a defined procedure whereby a part of a substance, material or product is taken to provide for testing or calibration of a representative sample of the whole. Sampling may also be required by the appropriate specification for which the substance, material or product is to be tested or calibrated. In certain cases (e.g. forensic analysis), the sample may not be representative but is determined by availability.

NOTE 2 Sampling procedures should describe the selection, sampling plan, withdrawal and preparation of a sample or samples from a substance, material or product to yield the required information.

5.7.2 Where the customer requires deviations, additions or exclusions from the documented sampling procedure, these shall be recorded in detail with the appropriate sampling data and shall be included in all documents containing test and/or calibration results, and shall be communicated to the appropriate personnel.

5.7.3 The laboratory shall have procedures for recording relevant data and operations relating to sampling that forms part of the testing or calibration that is undertaken. These records shall include the sampling procedure used, the identification of the sampler, environmental conditions (if relevant) and diagrams or other equivalent means to identify the sampling location as necessary and, if appropriate, the statistics the sampling procedures are based upon.

5.8 Handling of test and calibration items
5.8.1 The laboratory shall have procedures for the transportation, receipt, handling, protection, storage, retention and/or disposal of test and/or calibration items, including all provisions necessary to protect the integrity of the test or calibration item, and to protect the interests of the laboratory and the customer.

5.8.2 The laboratory shall have a system for identifying test and/or calibration items. The identification shall be retained throughout the life of the item in the laboratory. The system shall be designed and operated so as to ensure that items cannot be confused physically or when referred to in records or other documents. The system shall, if appropriate, accommodate a sub-division of groups of items and the transfer of items within and from the laboratory.

5.8.3 Upon receipt of the test or calibration item, abnormalities or departures from normal or specified conditions, as described in the test or calibration method, shall be recorded. When there is doubt as to the suitability of an item for test or calibration, or when an item does not conform to the description provided, or

the test or calibration required is not specified in sufficient detail, the laboratory shall consult the customer for further instructions before proceeding and shall record the discussion.

5.8.4 The laboratory shall have procedures and appropriate facilities for avoiding deterioration, loss or damage to the test or calibration item during storage, handling and preparation. Handling instructions provided with the item shall be followed. When items have to be stored or conditioned under specified environmental conditions, these conditions shall be maintained, monitored and recorded. Where a test or calibration item or a portion of an item is to be held secure, the laboratory shall have arrangements for storage and security that protect the condition and integrity of the secured items or portions concerned.

NOTE 1 Where test items are to be returned into service after testing, special care is required to ensure that they are not damaged or injured during the handling, testing or storing/waiting processes.

NOTE 2 A sampling procedure and information on storage and transport of samples, including information on sampling factors influencing the test or calibration result, should be provided to those responsible for taking and transporting the samples.

NOTE 3 Reasons for keeping a test or calibration item secure can be for reasons of record, safety or value, or to enable complementary tests and/or calibrations to be performed later.

1.4 What does the CODEX say about Sampling

GENERAL GUIDELINES ON SAMPLING
CAC/GL 50-2004

http://www.unece.org/fileadmin/DAM/trade/agr/meetings/ge.02/2013/CAC_GL-050e-2004.pdf

The following text was taken from the CODEX:

GENERAL GUIDELINES ON SAMPLING

Codex Food Standards are aimed at protecting consumers' health and ensuring fair practices in the food trade.

Codex Methods of Sampling are designed to ensure that fair and valid sampling procedures are used when food is being tested for compliance with a particular Codex commodity standard. The sampling methods are intended for use as international methods designed to avoid or remove difficulties which may be created by diverging legal, administrative and technical approaches to sampling and by diverging interpretation of results of analysis in relation to lots or consignments of foods, in the light of the relevant provision(s) of the applicable Codex standard.

The present guidelines have been elaborated to facilitate the implementation of these goals by Codex Commodity Committees, governments and other users.

BASIC RECOMMENDATIONS FOR THE SELECTION OF CODEX SAMPLING PLANS

The present clause represents a pre-requisite to the use of these Guidelines, and is intended to facilitate the selection of Codex sampling plans, as well as to follow a systematic approach for this selection.

The following enumerates the essential points that the Codex commodity committees, Governments and other users should address for the selection of appropriate sampling plans, when setting-up specifications.

1) Existence (or not) of international reference documents on sampling of the considered products
2) Nature of the control
• Characteristic applicable to each individual item of the lot
• Characteristic applicable to the whole lot (statistical approach)
3) Nature of the characteristic to control
• Qualitative characteristic (characteristic measured on a pass/failed or similar basis, i.e. presence of a pathogen micro-organism)
• Quantitative characteristic (characteristic measured on a continuous scale, for example a compositional characteristic)
4) Choice of the quality level (AQL or LQ)
• In accordance with the principles laid down in the Codex Manual of Procedures and with the type of risk: critical/ non-critical non-conformities.
5) Nature of the lot
• Bulk or pre-packed commodities
• Size, homogeneity and distribution concerning the characteristic to control
6) Composition of the sample
• Sample composed of a single sampling unit
• Sample composed of more than one unit (including the composite sample)
7) Choice of the type of sampling plan
• acceptance sampling plans for statistical quality control
    - for the control of the average of the characteristic
    - for the control of per-cent non-conforming items in the lot
- Definition and enumeration of non-conforming items in the sample (attribute plans)
- Comparison of the mean value of the items forming the sample with regards to an algebraic formula (variable plans).

1.5 What does Eurachem / CITAC say about Sampling

Measurement uncertainty arising from sampling (2007)

http://www.eurachem.org/index.php/publications/guides/musamp

The following text was taken from the Eurachem website:

Summary
This Guide aims to describe various methods that can be used to estimate the uncertainty of measurement, particularly that arising from the processes of sampling and the physical preparation of samples. It takes a holistic view of the measurement process to include all of these steps as well as the analytical process, in the

case where the measurand is defined in term of the value of the analyte concentration in the sampling target, rather than in just the sample delivered to the laboratory.

The Guide begins by explaining the importance of knowing the total uncertainty in a measurement for making reliable interpretation of measurements, and judging their fitness for purpose. It covers the whole measurement process, defining each of the component steps, and describing the effects and errors that cause uncertainty in the final measurement.

Two main approaches to the estimation of uncertainty from sampling are described.
The empirical approach uses repeated sampling and analysis, under various conditions, to quantify the effects caused by factors such as the heterogeneity of the analyte in the sampling target and variations in the application of one or more sampling protocols, to quantify uncertainty (and usually some of its component parts).

The modelling approach uses a predefined model that identifies each of the component parts of the uncertainty, making estimates of each component, and sums them in order to make an overall estimate. Models from sampling theory can sometimes be used in this approach to estimate some of the components from a knowledge of the characteristics of particulate constituents.

2.0 Definitions

2.1 Definition of Sampling

Merriam-Webster Dictionary

The act, process, or technique of selecting a suitable sample; specifically: the act, process, or technique of selecting a representative part of a population for the purpose of determining parameters or characteristics of the whole population.

The collection of a representative sample in order to assess baseline environmental conditions, to provide an assessment of compliance with environmental guidelines and to allow time-series analyses of the variation of parameters over extended periods of time.

2.2 Definition of a Sample

http://www.merriam-webster.com/dictionary/sample

Sample, noun

- a small amount of something that gives you information about the thing it was taken from
- a small amount of something that is given to people to try
- a group of people or things that are taken from a larger group and studied, tested, or questioned to get information

- a representative part or a single item from a larger whole or group especially when presented for inspection or shown as evidence of quality
- a finite part of a statistical population whose properties are studied to gain information about the whole
- We would like to see a sample of your work.
- I tasted a sample of the new cereal.
- Free samples were handed out at the store.
- The sample included 96 women over the age of 40.
- A random sample of people filled out the survey.
- We looked at a representative sample of public schools.

Sample, transitive verb

- to taste a small amount of (something)
- to try or experience (something)
- to test, study, or question (a group of people or things taken from a larger group) to get information
- to take a sample of or from;
- to judge the quality of by a sample :
- sampled his output for defects
- sample a wine
- She sampled everything the resort had to offer, from golfing to yoga.
- A low percentage of the women sampled said that they smoked during pregnancy.
- Five of the 20 schools sampled did not meet the standards.

Sample adjective

- used as an example of something
- The teacher handed out a sample essay.
- Here are some sample questions for the test.
- a representative part or a single item from a larger whole or group especially when presented for inspection or shown as evidence of quality : a blood sample
- a finite part of a statistical population whose properties are studied to gain information about the whole

For further definitions of sample, sampling, sampling point, etc. see Measurement uncertainty arising from sampling: A guide to methods and approaches (2007) which is further referenced in section 5.7 of this document.

http://www.eurachem.org/index.php/publications/guides/musamp

2.3 Definition of a Measurand:

Particular quantity subject to measurement.
Note: Specification of a measurand may require statements about quantities such as time, temperature and pressure.

From the EURACHEM Guide, The Fitness for Purpose of Analytical Methods, A Laboratory Guide to Method Validation and Related Topics, 1998

2.4 Definition of a Representative Sample

Most documents tell us that it is important to collect a representative sample. However it is often difficult to define what a representative sample is and exactly how to collect it. Below are examples of how various organizations have defined a representative sample.

In any case the representative sample, once collected, must be placed in a appropriate container, properly preserved and transported to the laboratory for analysis within established holding times. More on sample preservation and transport can be found in Section 7 of this document.

From the Eurachem Sampling Uncertainty document

1.5.2 Sampling theory has developed largely independently of analytical chemistry and chemical metrology. Sampling quality has generally been addressed in sampling theory by the selection of a 'correct' sampling protocol, appropriate validation, and training of sampling personnel (i.e. samplers) to ensure that this protocol is applied correctly [6]. It is then assumed that the samples will be representative and unbiased, and the variance will be that predicted by the model.

9.5.4 In addition to an initial single estimate of uncertainty for a particular sampling protocol applied to a particular sampling target, routine application of the 'duplicate method' is also useful as a way of monitoring the ongoing sampling quality. This can allow for the effect on uncertainty of changes in the heterogeneity of the sampling target between different applications of the same sampling protocol. Quantitative evidence of the quality of sampling can then be gained, rather than relying solely on the assumption that samples are representative, if taken by a correct protocol.

See Appendix B: Terminology of Eurachem Sampling Uncertainty document for several other definitions of sample and sampling.

From the CODEX Food Sampling manual:

A representative sample is a sample in which the characteristics of the lot from which it is drawn are maintained. It is in particular the case of a simple random sample where each of the items or increments of the lot has been given the same probability of entering the sample.

From the USEPA Guidance for Choosing a Sampling Design for Environmental Data Collection, Use in the Development of a Quality Assurance Project Plan (section 4.3 of this document).

2.4.1 IUPAC (1990) [46], ISO 11074-2: 1.9 (1998)

Representative sample: Sample resulting from a sampling plan that can be expected to reflect adequately the properties of interest in the parent population.

2.4.2 - New Approach to Geochemical Measurement: Estimation of Measurement Uncertainty from Sampling, rather than an Assumption of Representative Sampling

Michael H. Ramsey and Katy A. Boon
Department of Biology and Environmental Science, School of Life Sciences, University of Sussex, Brighton, UK
Geostandards and Geoanalytical Research [a]2010 International Association of Geoanalysts

http://www.cala.ca/sampling/27_New_Approach.pdf

This paper discusses Fitness for Purpose in the context of sampling; a comparison between in-situ and ex-situ analysis and that uncertainty in sampling is often the dominant uncertainty component. This sometimes makes less precise in-situ analysis techniques more Fit for Purpose than more costly and time consuming lab testing.

The following text was taken from the New Approach to Geochemical Measurement: Estimation of Measurement Uncertainty from Sampling, rather than an Assumption of Representative Sampling paper:

Abstract
It is argued that the current division between field sampling and chemical analysis is counterproductive in terms of ensuring that geochemical measurement results are fit for their intended purpose. An integrated approach to the whole measurement process has many advantages including no dependence on the two assumptions that either the samples are necessarily representative if taken with a correct protocol, or that the measurement results can be assumed to be true values of chemical concentration. The measurement results then require values of measurement uncertainty, including that from sampling as well as from chemical analysis. This enables the user of the measurement results, rather than the producer, to judge their fitness for a specific purpose. Case studies are used to illustrate the practicality and benefits of this new approach, including the use of measurement results with optimal, but relatively high, levels of uncertainty to make reliable decisions. This contrasts with the traditional assumption that pursuit of the lowest possible measurement uncertainty is the best approach.

Representative Sampling
These equations describe sampling error (e) as a fraction of the mass of analyte in the sampling target.

$$e = (a_S - a_L) / a_L$$

Representativeness of the samples (r_e) should ideally be less than the maximum acceptable representativeness of the samples (r_o).

$$(r_e^2 = m_e^2 + s_e^2) \leq (r_o^2 = m_o^2 + s_o^2)$$

Where:

e = sampling error
a_s = mass of analyte in the sample
a_L = mass of analyte in the sampling target or lot

r_e = representativeness of the samples
m_e = mean value of the sampling bias – systematic error
s_e = sampling precision – random error

r_o = maximum acceptable representativeness of the samples
m_o = maximum acceptable value of the sampling bias
s_o = maximum acceptable value of sampling precision

The two above equations are derived from two another sources (Petersen et al (2005), based on Gy (1992). They are not recommended in Dr. Ramsey`s 2010 paper, but used to point out the limitations of this approach (e.g. no transparent way of setting the maximum level of representativeness) and therefore better to optimise the uncertainty using the fitness for purpose approach described in Ramsey et al. 2002.

See Appendix 3. List of References and related reading for these references.

2.4.3 - Guidance Manual on Sampling, Analysis and Data Management for Contaminated Sites, Volume 1: Main Report

December 1993
PN 1101
Canadian Council of Ministers of the Environment

http://www.cala.ca/sampling/54_CCME_Guidance_Manual_on_Sampling_Vol_1.pdf

See page 29 and other pages for a discussion on representative sampling.

The following text was taken from the Guidance Manual on Sampling, Analysis and Data Management for Contaminated Sites, Volume 1: Main Report:

Abstract
This manual is one of a series of technical support documents being prepared under the National Contaminated Sites Remediation Program of the Canadian Council of Ministers of the Environment (CCME). Use of this manual will provide a consistent approach to Sampling, Analysis and Data Management for Contaminated Sites on a national basis. The primary objectives of this manual are:

- to provide guidance on sampling and analysing complex environmental matrices such that the data obtained will be representative and of known quality.
- To reduce the selection of the many available methods in use to a few of the best so that future analytical data from multiple participating laboratories will be consistent and comparable.

The manual stresses the significance of quality assurance (QA), quality control (QC) and planning, and emphasises the interdependence of sampling, analysis and data management objectives in the planning and execution of tasks within each of these three areas.

2.5 Definition of Chain of Custody

http://legal-dictionary.thefreedictionary.com/chain+of+custody

Chain of Custody
The movement and location of physical evidence from the time it is obtained until the time it is presented in court.

Court-rendered judgments and jury verdicts that are based on tainted, unreliable, or compromised evidence would undermine the integrity of the entire legal system if such outcomes became commonplace. One way in which the law tries to ensure the integrity of evidence is by requiring proof of the chain of custody by the party who is seeking to introduce a particular piece of evidence.

Proof of a chain of custody is required when the evidence that is sought to be introduced at trial is not unique or where the relevance of the evidence depends on its analysis after seizure. A proper chain of custody requires three types of testimony: (1) testimony that a piece of evidence is what it purports to be (for example, a litigant's blood sample); (2) testimony of continuous possession by each individual who has had possession of the evidence from the time it is seized until the time it is presented in court; and (3) testimony by each person who has had possession that the particular piece of evidence remained in substantially the same condition from the moment one person took possession until the moment that person released the evidence into the custody of another (for example, testimony that the evidence was stored in a secure location where no one but the person in custody had access to it).

Proving chain of custody is necessary to "lay a foundation" for the evidence in question, by showing the absence of alteration, substitution, or change of condition. Specifically, foundation testimony for tangible evidence requires that exhibits be identified as being in substantially the same condition as they were at the time the evidence was seized, and that the exhibit has remained in that condition through an unbroken chain of custody. For example, suppose that in a prosecution for possession of illegal narcotics, police sergeant A recovers drugs from the defendant; A gives police officer B the drugs; B then gives the drugs to police scientist C, who conducts an analysis of the drugs; C gives the drugs to police detective D, who brings the drugs to court. The testimony of A, B, C, and D constitute a "chain of custody" for the drugs, and the prosecution would need to offer testimony by each person in the chain to establish both the condition and identification of the evidence, unless the defendant stipulated as to the chain of custody in order to save time.

Whether the requisite foundation has been laid to establish chain of custody for an exhibit is a matter of discretion on the part of the trial judge. Possibilities of misidentification and adulteration must be eliminated, not absolutely, but as a matter of reasonable probability. Where there is sufficient testimony that the evidence is what it purports to be, and that testimony is offered by each responsible person in the chain of custody, discrepancies as to accuracy or reliability of testimony regarding the chain of custody go to the weight of the evidence and not to its admissibility, meaning that the evidence would be admitted into the record for the judge or jury to evaluate in light of any conflicting testimony that the chain of custody somehow had been compromised. While the party who offers the evidence has the burden of demonstrating the chain of custody, the party against whom the evidence is offered must timely object to the evidence when it is first introduced at trial, or the party will waive any objections as to its integrity based on a compromised chain of custody.

3.0 Legal Sampling, Consequences of Sampling

Madame, what is that white powder in the bag that we have found in your purse.

If this boatload of stainless steel assays at 18% Chromium or greater, I will buy the boatload for 10 million dollars. If it misses the required specification, I will not.

This sample has tested at 55 ± 10 mg per kg PCB, k = 2. The legal limit is 50 mg per kg PCB. Does this apparent violation justify a million dollar fine and a plant shutdown?

Sometimes the consequences of sampling and analysis can be quite large, other times the data, although important, are simply part of a larger dataset.

3.1 - Guideline on Sampling, Handling, Transporting, and Analyzing Legal Wastewater Samples

Canadian Water and Wastewater Association
Unit 11, 1010 Polytek Street
Ottawa, ON
K1J 9H9

http://www.cala.ca/sampling/12_CWWA_LEGAL_SAMPLING_GUIDELINE.pdf

The following text was taken from the Guideline on Sampling, Handling, Transporting, and Analyzing Legal Wastewater Samples document:

1.1 OBJECTIVES
The purpose of the guideline is to define standard operating procedures, methods and considerations that are to be used and observed when collecting and handling wastewater (or other) legal samples for field screening, laboratory analysis and evaluation for potential enforcement and legal actions in court. The guideline is intended to supplement the various sampling reference methods and clearly identify the points and requirements specific to the legal sampling procedure. It can assist in ensuring that the legal sampling criteria are established on a formal basis and accepted by all involved.

The development of the Guideline primarily is led by the ISO/IEC 17025 Standard management requirements. The guideline promotes a set of appropriate forms of documentation to support the legal samples as conclusive evidence in the case of prosecution. Furthermore, it assists municipal laboratories in developing their own continuity documentation during such activities as field sampling, sample receiving, sample storage, sample analysis, sample disposal and chain of custody procedures.

2. LEGAL, COURT OR EVIDENTIARY SAMPLE
Legal samples are samples collected and handled for court purposes and are intended to be used as evidence for a possible prosecution concerning the sample origin, type and constituents. In comparison to the non-legal samples, the legal sample should demonstrate more stringent proof of custody from the time of collection to the time of analysis and disposal. The sample collection procedure itself may be equivalent to

the routine sampling, but the sample handling and documentation requirements are more stringent. The legal samples must also confirm the samples could not have been tampered with at any stage and therefore they require special care due to the influence they may have on a court case.

3.2 - Guidelines on Representative Drug Sampling

In cooperation with the Drugs Working Group of the European Network of Forensic Science Institutes
Laboratory and Scientific Section
United Nations Office on Drugs and Crime
Vienna
New York, 2009
UNITED NATIONS PUBLICATION
Sales No. E.09.XI.13
ISBN 978-92-1-148241-6

http://www.cala.ca/sampling/13_Drugs_Sampling_Guideline_UNODC-ENFSI.pdf

The following text was taken from the Guidelines on Representative Drug Sampling document:

Introduction
The present guidelines describe a number of sampling methods, from arbitrary methods to methods with a statistical background. They focus on sampling in cases where large numbers of relatively homogeneous material are available. They do not deal with so-called tactical sampling, which may be applied for house-searches or in clandestine laboratory investigations. These cases are characterized by different materials, sometimes in different amounts, different packages and/or sometimes with different suspects; these cases are considered as so specific and so dependent on the situation (also in legal aspects) that a guideline would be inadequate in many cases. Thus, the present guidelines contain a number of sampling strategies for cases with large numbers of items of relatively homogeneous material. However, from the descriptions of the sampling methods, it is not automatically clear which strategy should be preferred (or would be optimum). This is mainly due to the fact that it is not possible to define a sampling strategy, if the requirements have not been defined. This is the main reason why it was decided to refrain from giving advice at local, regional or national level.

In guidelines for wider application, such as the present guidelines, the advice cannot be as fine-tuned as it can be in a specific agreement between prosecutor, police, and chemist and laboratory management at local, national or regional level.

However, some aspects of sampling for international cases are discussed in chapter 6 and in annex II. Here, the advantages and disadvantages of various methods, also in relation with sampling practice, are brought up. It seems that a Bayesian approach is a reasonable one in many cases, but its complexity might be a major drawback, especially for court. Fortunately, the hypergeometric and Bayesian approaches appear to show more or less the same results in cases where no prior probability is used.

Since sampling is often carried out by police and customs, the guidelines refrain from giving advice where the number of samples must be calculated for each separate case; this would be confusing and bother law enforcement personnel with computers or lists with Bayesian and hypergeometric tables. Therefore the final

sampling advice just mentions the (minimum) number of samples to be taken (5, 8 or 11, the number of samples being dependent on the circumstances). The forensic laboratory can then, if necessary, perform the final evaluation and probability calculations.

The present guidelines aim to support drug analysis laboratories in the selection of their sampling strategy(ies) and best working practices.

3.3 - Conducting Environmental Compliance Inspections

Inspector's Field Manual International Edition
United States Washington DC
Environmental Protection Agency United States of America
Office of Enforcement & Compliance Assurance August, 2002

http://www.cala.ca/sampling/15_English_Inspectors_Field_Manual.pdf

The following text was taken from Conducting Environmental Compliance Inspections-
Inspector's Field Manual International Edition:

ABOUT THIS MANUAL
This manual represents one internationally accepted model for conducting compliance inspections. However, other models exist that may be equally or more applicable to a particular regulation or program. It is not designed as guidance for conducting any specific type of inspection. That information will be found in specialized program training. Here you will find only the basics — information you may refer to occasionally to regain your footing on a familiar shore.

This manual was adapted from a U.S. EPA inspection manual written by W. Douglas Smith. It is co-edited and adapted for international use by Mr. Smith, and Davis Jones of EPA's International Enforcement and Compliance Division. It is designed as a stand-alone manual, but is also used in conjunction with broader initiatives set forth in U.S. EPA's International programs.

The material covered here is written in plain language with examples intended to be relevant to the widest possible audience. Long experience has shown that students have had better retention and understanding when their instruction is personalized.

Sample documentation centers around four prime issues: insuring that the sample is representative, tracking the sample, using proper methodology, and reporting the data in a form that is applicable. The procedures necessary to accomplish this are outlined in the QAPP. (Quality Assurance Program Plan)

1. Was the sample representative of what you wanted to evaluate for compliance? Did it represent a specific waste stream, site, event, or time period?

2. Can you prove where it came from, where it went, what was done to it, and that there was not an opportunity to compromise the sample along the way? A standard form that tracks everyone who handled the sample and when it entered and left their possession is useful to establish the "chain of custody."

3. Was the correct methodology followed to insure that the sample was (a) taken properly for the substance and matrix in question, and (b) were the proper analytical methods used to make an accurate and precise evaluation?

4. Was the analytical data reported in the appropriate units to determine compliance? Were all quality assurance and quality control measures also reported?

These are a few of the tools used to track sampling events:
• Field log or notebook
• Field photography
• Field lab data sheet
• Sample numbers
• Sample labels
• Analysis request
• QAPP
• Sample plan
• Check lists
• Field generated diagrams, maps and measurements
• Chain of custody

3.4 - The Inspector's Field Sampling Manual, 2nd Edition

Environment Canada
ISBN 0-662-38953-0
Cat. No En40-498/2005E

http://www.cala.ca/sampling/16_En40-498-2005-1E.pdf

The following text was taken from the Inspector's Field Sampling Manual:

Introduction
This manual has been written to provide national standards and uniformity in environmental sampling for samplers including enforcement officers, other public officers and lay samplers.

This manual draws on established procedures and protocols, legislative and regulatory requirements, scientific literature and experience of Environment Canada inspectors, investigators and laboratory staff across Canada. Environmental sampling is a complex field and technology is evolving rapidly, you should stay aware of changes to legislation, regulations, methods and standard practices, as they occur.

Sampling can be undertaken for various reasons, including inspection of regulated facilities, investigation of suspected violations, routine monitoring, research projects and emergency response. This manual focuses on sampling for inspections, investigations and emergency response.

3.5 - The Inspector's Safety Guide, 2nd Ed. 2005

Environment Canada

ISBN 0-662-39415-1
Cat. No. En40-500/2005E

http://www.cala.ca/sampling/42_The_Inspectors_Safety_Manual.pdf

The following text was taken from The Inspector's Safety Guide:

Introduction
This manual has been written to provide national standards and uniformity in safety guidance in conducting inspections and to serve as a training reference guide for inspectors in the field. Although some specific warnings on hazards involved in sampling procedures are included in this manual, inspectors should also familiarize themselves with The Inspector's Sampling Manual along with Environment Canada's Task Hazard Analysis for specific tasks related to inspection work.

3.6 - Public Health Inspector's Guide to the Principles and Practices of Environmental Microbiology.

4th ed. Toronto, ON: Queen's Printer for
Ontario; 2013.
FEBRUARY 2013
Ontario Agency for Health Protection and Promotion (Public Health Ontario).
ISBN 978-1-4606-0678-0 [PDF]
ISBN 978-1-4606-0677-3 [Print]

For more information, visit www.oahpp.ca

http://www.cala.ca/sampling/28_PHO_PUBLIC_HEALTH_INSPECTORS_GUIDE_2013.pdf

The following text was taken from the Public Health Inspector's Guide to the Principles and Practices of Environmental Microbiology:

Public Health Ontario (PHO) is a Crown corporation dedicated to protecting and promoting the health of all Ontarians and reducing inequities in health. As a hub organization, PHO links public health practitioners, frontline health workers and researchers to the best scientific intelligence and knowledge from around the world.

The PHO laboratory provides microbiological tests for food samples, water samples, suspected contamination with sewage and Legionella Investigations. Sample Collection and Transportation Instructions are provided for all the tests.

3.7 - Tabs on Contaminated Sites, Tab #5 Sampling & Analysis of Hydrocarbon Contaminated Groundwater

Contaminated Sites Program - Federal Sites

This is one in a series of Technical Assistance Bulletins (TABs) prepared by
Environment Canada-Ontario Region for Federal Facilities operating in Ontario.
Environment Canada, Ontario Region has published TABS which describe sampling that is often done for regulatory and compliance purposes for Federal Facilities operating in Ontario.

For further information please contact:
Environment Canada
Ontario Region - Environmental Protection Branch
Environmental Contaminants &
Nuclear Programs Division
4905 Dufferin Street
Downsview, ON M3H 5T4
Our TABs can be found on the Internet at:
http://www.on.ec.gc.ca/pollution/ecnpd/

http://www.cala.ca/sampling/35_sampling_PHC_groundwater_contab5.pdf

The following text was taken from Tabs on Contaminated Sites, Tab #5:

This TAB is intended to outline proper procedures for sampling and analysis of hydrocarbon contaminated groundwater. These procedures are also applicable to groundwater monitoring programs for contaminants other than hydrocarbons, although there may be variations in the analytical methods and parameters used for other programs. For additional parameters, we recommend that the CCME Interim Environmental Quality Criteria for Contaminated Sites document be consulted, along with other federal and provincial regulations, guidelines, and codes of practice.

1. MONITORING WELL LOCATION
Monitoring well location is a function of the site's flow conditions and the distribution of contaminant source(s). The best location for wells is determined by utilizing site screening methods which would identify and delineate the general extent and location
of contamination (refer to TABs #2 and #3).

DESCRIPTION:
Based on the results of geophysical and soil vapour surveys, monitoring wells and piezometers are placed in strategic positions, and representative ground-water samples are collected and analyzed. The objective of a ground-water monitoring program is to identify, interpret and track the movement of a contaminant plume so that a comprehensive remediation program can be implemented if deemed necessary.

3.8 - Tabs on Contaminated Sites, Tab#2 Site Assessment Procedures

Contaminated Sites Program - Federal Sites
This is one in a series of Technical Assistance Bulletins (TABs) prepared by
Environment Canada-Ontario Region for Federal Facilities operating in Ontario.

Environment Canada, Ontario Region has published TABS which describe sampling that is often done for regulatory and compliance purposes for Federal Facilities operating in Ontario.

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Environment Canada
Ontario Region - Environmental Protection Branch
Environmental Contaminants &
Nuclear Programs Division
4905 Dufferin Street
Downsview, ON M3H 5T4
Our TABs can be found on the Internet at:
http://www.on.ec.gc.ca/pollution/ecnpd/

http://www.cala.ca/sampling/36_site_assessment_procedures_Tab2.pdf

This document contains information on sampling and analysis of hydrocarbons in environmental samples.

The following text was taken from Tabs on Contaminated Sites, Tab#2:

DESCRIPTION:
The purpose of a site assessment is to identify the existence, source, nature, and extent of contamination by hazardous substances, and to determine the threat posed to human health or the environment by the contamination.

3.9 - Tabs on Contaminated Sites, TAB #4 Sampling & Analysis of Hydrocarbon Contaminated Soil

Contaminated Sites Program - Federal Sites
This is one in a series of Technical Assistance Bulletins (TABs) prepared by
Environment Canada-Ontario Region for Federal Facilities operating in Ontario.

Environment Canada, Ontario Region has published TABS which describe sampling that is often done for regulatory and compliance purposes for Federal Facilities operating in Ontario.

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Environment Canada
Ontario Region - Environmental Protection Branch
Environmental Contaminants &
Nuclear Programs Division
4905 Dufferin Street
Downsview, ON M3H 5T4
Our TABs can be found on the Internet at:
http://www.on.ec.gc.ca/pollution/ecnpd/

http://www.cala.ca/sampling/37_sampling-hydrocarbon-soil.pdf

The following text was taken from Tabs on Contaminated Sites, TAB #4:

DESCRIPTION:
Soil samples must be collected for laboratory analysis at all petroleum release sites to document the type, location and degree of soil contamination. In order to properly characterize the soil, samples must adequately reflect the properties of the site being sampled. Proper sampling and analytical procedures of petroleum contaminated sites are outlined in this TAB.

This TAB deals with the sampling and analysis of hydrocarbon contamination, but the same procedures can be used for other types of contaminants, although the analysis criteria will differ.

3.10 - Guidelines for Legal Sampling, Sask. Ministry of Environment EPB 264

Drinking Water Quality Section
October 2003
Revised Feb/04

Guidelines for Legal Sampling, Sask. Ministry of Environment EPB 264

http://www.cala.ca/sampling/63_EPB_264_Guidelines_for_Legal_Sampling.pdf

The following text was taken from Guidelines for Legal Sampling, Sask. Ministry of Environment EPB 264:

1. Introduction
Legal samples are those samples collected as evidence for a possible prosecution under provincial legislation. Two factors distinguish legal samples from routine samples:

• you must be able to demonstrate that the samples could not have been tampered with at any stage in their handling and shipping; and
• you must be able to demonstrate continuity of custody of the samples from the time of collection to the time of analysis.

In the field, legal sampling requires the following additional effort:

• you must have traceable clean containers whose cleanliness can stand up to a potential court challenge;
• you must have proper seals and labels and sealed (locked) containers for the samples; and
• you must be able to track the custody of the samples and show that they could not have been tampered with.

This document is designed to guide enforcement and technical staff in sampling and analysis to support a legal proceeding. Included within the document are powers and authorities under Saskatchewan Environment (SE) legislation, field procedures and procedures following laboratory analysis. More specific information on sampling safety, protocols and procedures are available by referencing “The Inspector’s Field Sampling Manual” and “The Inspector’s Safety Guide”.

3.11 - Sampling and Analysis Protocol For Ontario Regulation 267/03

Made under the Nutrient Management Act, 2002

July 25, 2012
Ministry of Agriculture, Food and Rural Affairs
Ministry of the Environment

http://www.ontariocanada.com/registry/showAttachment.do?postingId=2304&attachmentId=15917

The following text was taken from Sampling and Analysis Protocol for Ontario Regulation 267/03:

1.0 Introduction
Proper sampling and analytical techniques are critical to accurately determine the nutrient content and other properties of materials applied to the land for the purpose of improving the growing of agricultural crops. Proper techniques have always been important, but they are now a legal requirement under the Nutrient Management Act, 2002. The techniques described in this document are intended to meet the requirements of the regulations under the Act. They can also provide guidance for other sampling and analysis requirements with similar goals.

In this document a nutrient management plan required by the regulation for a Farm Unit will be denoted as an NMP. A nutrient management plan required for the application of non agricultural source materials (NASM) will be denoted as a NASM Plan.

3.12 - Sampling and Testing for Lead

Ontario Ministry of Environment
Annual sampling and testing for lead
Safe Drinking Water Act, 2002
ONTARIO REGULATION 243/07
SCHOOLS, PRIVATE SCHOOLS AND DAY NURSERIES

http://www.e-laws.gov.on.ca/html/regs/english/elaws_regs_070243_e.htm#BK7

The following text was taken from the Sampling and Testing for Lead document:

The operator of a school, private school or day nursery shall ensure that samples of water are taken in accordance with the following rules:

1. Except in a year in which paragraph 2 applies to a school, private school or day nursery, the samples must be taken at least once in each calendar year, during the period beginning on May 1 and ending on October 31.

2. If the school, private school or day nursery commences operation on or after December 14, 2009, the samples must be taken at least once within 30 days after the first day of operation and, if operation commences during a period beginning on January 1 and ending on March 31, at least once during the period beginning on May 1 and ending on October 31 in the same calendar year during which operation commences.

2.1 The samples must consist of two one-litre samples of cold water taken from the same tap or fountain.

3. If the tap or fountain from which the samples are to be taken has an aerator, the aerator must not be removed while the samples are being taken.

4. If a filter or other device that treats water is installed on or near the tap or fountain from which the samples are taken and it is practicable to bypass the filter or other device without removing it, the filter or other device must be bypassed while the samples are being taken.

5. The samples must be taken from,

i. any tap that is used in the preparation of food or drink for consumption by children under 18 years of age,

ii. any tap that is commonly used to provide water for consumption by children under 18 years of age, or

iii. if it is practicable to collect a sample from a drinking water fountain in accordance with this section, any drinking water fountain.

3.13 - Use of uncertainty information in compliance assessment. (2007)

EURACHEM/CITAC Guide:
First edition 2007
Editors
S L R Ellison (LGC, UK)
A Williams (UK)

http://www.eurachem.org/index.php/publications/guides/uncertcompliance

The following text was taken from the Use of uncertainty information in compliance assessment:

Content
In order to decide whether a result indicates compliance or non-compliance with a specification, it is necessary to take into account the measurement uncertainty associated with the result. This guide provides guidance on how uncertainty may be taken into account in deciding compliance with a limit.

The guide is applicable to decisions on compliance with regulatory or manufacturing limits where a decision is made on the basis of a measurement result accompanied by information on the uncertainty associated with the result. It covers cases where the uncertainty does not depend on the value of the measurand, and cases where the uncertainty is proportional to the value of the measurand.

The guide includes a discussion and general recommendations, followed by more detailed instructions on establishing rules for interpretation and by several examples.

3.14 - Australian EPA Guidelines - Regulatory monitoring and testing - Water and Wastewater Sampling

EPA Guidelines: Regulatory monitoring and testing, Water and wastewater sampling

Authors: David Duncan, Fiona Harvey, Michelle Walker and Australian Water Quality Centre. The EPA would like to acknowledge the assistance of the Australian Water Quality Centre in preparation of this document.

For further information please contact:
Information Officer
Environment Protection Authority
GPO Box 2607
Adelaide SA 5001

Email: <epainfo@epa.sa.gov.au>
Website: <www.epa.sa.gov.au>
ISBN 978-1-921125-47-8
June 2007

http://www.cala.ca/sampling/4_2013_sampling_protocol_epa.pdf

The following text was taken from the Australian EPA Guidelines - Regulatory monitoring and testing - Water and Wastewater Sampling document:

1 INTRODUCTION
1.1 Purpose
The purpose of this guideline is to set minimum standards and to provide practical guidance on water and wastewater sampling for regulatory purposes in South Australia.

1.2 Scope
This guideline applies to the sampling of waters and wastewaters including:
• receiving waters such as oceans, rivers, creeks and estuaries
• end-of-pipe or channel effluents and industrial process waters, cooling waters or wastewaters.

This guideline does not cover sampling of groundwaters. The EPA guidelines:
Groundwater sampling (2006a) should be consulted for advice on groundwater sampling.
For additional information not provided in the above guideline, we recommend that the AS/NZS 5667 series of standards be consulted. This guideline does not provide detailed guidance on analysis methods or interpretation of data.

1.3 Intended users
This guideline is primarily aimed at:
• sampling to determine compliance with environmental regulatory requirements, including authorisations under the Environment Protection Act 1993 (EP Act)
• collecting and/or analysing samples for comparison with the Environment Protection (Water Quality) Policy 2003 (Water Quality Policy) criteria.

However, given suitable justification, alternative methods may be approved for unique circumstances upon written application to the Environment Protection Authority (EPA).

This guideline may also provide guidance for water sampling for non-regulatory reasons such as collecting samples for ambient or hot spot monitoring. Any monitoring submitted to the EPA for these purposes should also meet the requirements of this guideline.

3.15 - Pollution Crimes Forensics Investigations Manual, Volume I of II

Interpol, Environmental Crime Program

Environment Canada and Interpol are preparing a draft Pollution Crimes Investigations Manual. The likely publication date within the next month or two.

The web site will be attached when it is ready.

The following text was taken from a draft version of the Pollution Crimes Forensics Investigations Manual, Volume I of II:

Collection of evidence and the preparation of the forensic environmental investigation brief
Successful prosecution of an environmental case involves four major steps:

1. Collection of the appropriate evidence.
2. Maintenance of legal continuity of the evidence.
3. Organization and documentation of evidence.
4. Presentation of the evidence to the various audiences (enforcement office management, police, prosecutors, judges and the court)

4.0 Design of Sampling Programs

If you are the forensic scientist entering the smouldering ruins looking for the cause of the blaze, you might look at the gas can next to the charred floorboard and decide to pull up that floorboard to test for gasoline. If it tests positive it is arson.

If you are the quality scientist controlling the pharmaceutical production plant, your samples will all be 500 mg ± 10 or 20 mg per capsule. If 10000 capsules per hour are produced, how many samples do you need to take to control the production line?

If you are exploring for Gold, Oil or Groundwater Contaminants, the samples are diverse in concentration and matrix type. How do you reliably find the place to build the mine or find the contaminated aquifer?

4.1. EMMA - Environmental Monitoring and Measurement Advisor

EMMA is provided by Instant Reference Sources, Inc. who develops and publishes software used as references, training aids, and planning tools by government agencies, lawyers and regulators, environmental engineering firms, educators, and health and safety professionals.

Internet Site: http://www.instantref.com

http://emma-expertsystem.com/

The following text was taken from the EMMA website:

EMMA is an expert system (interactive software) for project managers, administrators, and others who use or procure laboratory services for environmental analyses. It is used to plan improved and cost-effective environmental monitoring projects. It is also a highly effective teaching aid for instructors and students and was funded in part by the National Science Foundation (NSF). EMMA's new innovative technology leads you through complex decisions to tailor your plans to meet specific project needs by considering the physical and chemical characteristics of the sampling site and target analytes, desired data quality, available budget, your objectives, and the consequences of making wrong decisions based on the data you will obtain.

To do this EMMA combines decision criteria based on systematic planning (including all elements of EPA's Data Quality Objective (DQO) process), your specific project needs, and methods information from the new National Environmental Methods Index (NEMI). It also incorporates the latest information from EPA's new Triad Approach and EPA's new Performance and Acceptance Criteria (PAC) Process.

EMMA consists of three modules, each based on a group of interactive decision criteria. It helps you to consider, and answer, all critical questions for project planning so that you will have a plan that guarantees that you will get the right data on time the first time with no unpleasant surprises at the end.

• The first module incorporates decisions based on what, where, when, why, and how you plan to monitor a site (including your QA/QC requirements and budget).

• The second module (Method Selection) is freely available on the NEMI web site so that it can be used with NEMI and people can become familiar with the expert system and how it works.

• The third module calculates how many samples you'll need for your project requirements and matches that to your available budget and desired confidence levels in the data.

EMMA includes a tutorial, and a manual with a workbook. The workbook contains convenient forms for calculations of numbers of samples in relation to your budget and project objectives. EMMA is now free, courtesy of Instant Reference Sources, Inc.

4.2 - Guidance for Choosing a Sampling Design for Environmental Data Collection, Use in the Development of a Quality Assurance Project Plan

EPA QA/G-5S
U.S. Environmental Protection Agency
Quality Staff (2811R)
1200 Pennsylvania Ave., NW
Washington, D.C. 20460
Final, December 2002

http://www.epa.gov/quality/qs-docs/g5s-final.pdf

The following text was taken from the Guidance for Choosing a Sampling Design for Environmental Data Collection, Use in the Development of a Quality Assurance Project Plan document:

INTRODUCTION
This document provides guidance on how to create sampling designs to collect environmental measurement data. This guidance describes several relevant basic and innovative sampling designs, and describes the process for deciding which design is right for a particular application.

1.1 WHY IS SELECTING AN APPROPRIATE SAMPLING DESIGN IMPORTANT?
The sampling design is a fundamental part of data collection for scientifically based decision making. A well-developed sampling design plays a critical role in ensuring that data are sufficient to draw the conclusions needed.1 A sound, science-based decision is based on accurate information. To generating accurate information about the level of contamination in the environment, you should consider the following:

- the appropriateness and accuracy of the sample collection and handling method,
- the effect of measurement error,
- the quality and appropriateness of the laboratory analysis, and
- the representativeness of the data with respect to the objective of the study.

4.3 - Field Sampling Procedures Manual, August 2005

New Jersey
Department of Environmental Protection

http://www.cala.ca/sampling/21_NJ_Field_Sampling_Procedures_Manual_2005.pdf

The following text was taken from the Field Sampling Procedures Manual:

Introduction
The primary intent of the manual has always been to promote accuracy and consistency when environmental samples are collected and prepared for chemical analysis by public and private entities. The validity of analytical data is directly dependent upon the integrity of the field procedures employed to obtain a sample. The methods and procedures described herein are intended for use by those State of New Jersey regulatory agencies that require chemical, physical and certain biological analysis of samples for remedial evaluation and monitoring purposes. Since these methods are applicable to such a wide variety of regulatory programs throughout the Department, any site and/or regulatory specific questions/ issues regarding a particular sampling technique must be discussed with the applicable program personnel prior to going out into the field.

Furnishing guidance for a broad range of field activities is meant to improve the planning, implementation and documentation of most field-sampling activities. Said guidance may often suggest several ways to collect a sample, all of which may be scientifically correct under site or matrix specific circumstances.

Hyperlinks that direct the reader to a variety of web sites are intended to enhance specific information with the emphasis on enhance, not necessarily replace. Maintaining a balance between the evolving nature of

environmental sampling and well-established regulatory oversight means that care should be taken when preparing documents based on the procedures outlined herein. All methodologies presented in this manual may not be applicable to specific site situations; a certain procedure, though included in the text of the manual or by hyperlink reference may be disallowed at the discretion of NJDEP program personnel if determined inappropriate in a particular situation.

This manual has been prepared in an effort to represent the best available technology for field sampling activities associated with hazardous site investigations and remedial actions. It is also an appropriate reference for certain aspects of water data acquisition, water allocation, wastewater treatment operations, radiological assessment, geophysical investigations and other regulated programs that require field sampling. Procedures outlined herein have been developed through internal peer review, extensive literature research, practical field application and analysis of data from a quality assurance perspective.

Environmental sampling inherently may present extraneous variables, which may ultimately affect the outcome of analytical results. Since the nature of environmental media sampling warrants the analysis of a small aliquot relative to the bulk material, proper sampling techniques must be employed to obtain a sample which retains its scientific integrity and is legally defensible. To meet these conditions a sample must be collected and handled so as to keep its original physical form and chemical composition to as great an extent as possible. For a sample to be “representative” of a larger body of material in question, it is imperative to ensure sample integrity and maintain quality assurance standards in the field. The sampling procedures put forth in the text of this manual or by direct reference are designed to minimize any possibility of altering the sample’s integrity.

The achievement of consistency in sampling procedures and techniques helps to ensure the provision of data having acceptable quality, comparability and usability. The importance of data quality has been recognized through stringent laboratory quality control programs. This manual is intended to compliment these processes by establishing appropriate quality control during sampling collection. Quality assurance measures coupled with a comprehensive site specific sampling plan will improve the chance of collecting representative samples. This is important to ensure that public and private monetary resources are utilized in an effective manner.

4.4 - Requirements for the Preparation of Sampling and Analysis Plans, Department of the Army

U.S. Army Corps of Engineers
Washington, DC ~0314-1000

http://www.cala.ca/sampling/34_sampling_and_analysis_plans.pdf

The following text was taken from the Requirements for the Preparation of Sampling and Analysis Plans document:

Purpose
This manual provides guidance for the preparation of project-specific sampling and analysis plans (SAP) for the collection of environmental data. In addition, default sampling and analytical protocols are included which may be used verbatim or modified based upon project-specific data quality objectives (DQOs). The

goal of this manual is to promote consistency in the generation and execution of sampling and analysis plans and thus to help generate chemical data of known quality for its intended purpose.

4.5 - California EPA Surface Water Ambient Monitoring Program (SWAMP)

SWAMP QAPP Advisor: A Computer Based Tool for Developing QAPPs
Dawit Tadesse & Larry Keith
May 2008
National Water Quality Council Conference, Atlantic City, NJ

The following text was taken from the PowerPoint presentation describing the SWAMP expert system:

http://acwi.gov/monitoring/conference/2008/presentations/sessionG/G6B_Tadesse.pdf

What is the SWAMP QAPP Advisor?
It is a computer based tool that helps users produce a QAPP efficiently and accurately.
This tool is built using Expert Knowledge System

What is an Expert Knowledge System?
is an interactive computer program that provides the same answers and advice to questions that a human expert would.

Advantages Include:
•Ensures that all necessary questions are addressed and all forms needed are available.
•Advice and information is available at any time day or night 24 hours a day 7 days a week.
•Users quickly find specific information and advice for a particular situation without wasting time on extraneous information.
•Provides consistent advice (unlike humans).

4.6 - Monitoring, Sampling, and Analysis

US Environmental Protection Agency

http://www.epa.gov/oust/cat/monitor.htm

This website provides several links to USEPA sampling and analysis for sampling different types of sampling targets.

The following text was taken from the Monitoring, Sampling, and Analysis website:

A crucial part of cleanup actions is accurately and carefully measuring progress toward cleanup levels by monitoring sites, taking samples, and analyzing these data to measure progress toward that goal.

NOTE: QA documents referred to in some of the following publications may be outdated. Visit The EPA Quality System web site for the latest version of EPA's QA documents.

Air Emissions
Estimating Air Emissions from Petroleum UST Cleanups. This guidance document (June 1989) and companion field cards (September 1989) are intended to provide State regulators with a means of estimating air emission rates of VOCs and benzene at individual UST cleanup sites. This information may be used to develop policies regulating such air emissions.

Air Emissions from the Treatment of Soils Contaminated with Petroleum Fuels and Other Substances (PDF) Exit EPA Disclaimer (4 pp, 14K, About PDF). (EPA/600/SR-97/116), November 1997.

Groundwater Monitoring and Sampling
Handbook of Groundwater Protection and Cleanup Policies for RCRA Corrective Action
contains the Environmental Protection Agency's (EPA's) latest interpretation of policies on such topics as cleanup goals, the role of groundwater use, point of compliance, source control, and monitored natural attenuation

"Do Monitoring Wells Monitor Well? Part I." (PDF) (13 pp, 252K, About PDF) LUSTLine Bulletin 40, March, pp.13-16. (LL40WanderLust.pdf)

"Do Monitoring Wells Monitor Well? Part II. The Regulatory Basis For Monitoring Well Design, Siting, and Monitoring" (PDF) (17 pp, 278K, About PDF) LUSTLine Bulletin 41, June, pp.17-20. (LL41WanderLust.pdf)

"Ground-Water Monitoring in Karst Terranes - Recommended Protocols & Implicit Assumptions" (PDF) (EPA/600/X-89/050) March 1989 (88 pp, 573K, About PDF)
"Practical Guide for Ground-Water Sampling" (PDF) (103 pp, 1.4MB, About PDF) SWS Contract Report 374, November 1985

"Ground Water Sampling -- A Workshop Summary" (PDF) (158 pp, 914K, About PDF) (EPA/600/R-94/205) Dallas, Texas, November 30-December 2, 1993

"Groundwater Sampling Desk Reference" S. Karklins, WI DNR PUBL-DG-037 96, September 1996. Cover to Page 67 Exit EPA Disclaimer (77 pp, 1.25MB, About PDF)
Page 60 to Page 169 Exit EPA Disclaimer (110 pp, 1.25MB, About PDF)

"Handbook of Suggested Practices for the Design and Installation of Ground-Water Monitoring Wells" (PDF) (224 pp, 5.7MB, About PDF) (EPA/600/4-89/034) March 1991 *NOTE that this document does not cover direct push technologies. For information on direct push technologies see "Expedited Site Assessment Tools For Underground Storage Tank Sites: A Guide for Regulators". (EPA 510-B-97-001). March 1997.

Low-Flow/Minimal Drawdown/Low Stress/Micropurge Purging Technique "Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures" (PDF) (12 pp, 78K, About PDF) R.W. Puls and M.J. Barcelona. EPA Ground Water Issue, EPA/540/S-95/504 April 1996

"The Low-Down on Low Flow" Exit EPA Disclaimer Greg Giles and Jeff Story, NJ DEP, Site Remediation News, November 1997 (Vol 9 No 3) - Article 04.

"Low Stress (low flow) Purging and Sampling Procedure for the Collection of Ground Water Samples from Monitoring Wells" U.S. EPA Region 1, September 1996.

"Field Manual for Water Quality Sampling" Exit EPA Disclaimer Arizona Water Resources Research Center, College of Agriculture, The University of Arizona, Tucson, March 1995.

Soil Sampling
"Preparation of Soil Sampling Protocols: Sampling Technologies and Strategies" (PDF) (169 pp, 2.5MB, About PDF) (EPA/600/R-92/128) July 1992
Soil Screening Guidance

"A Rationale for the Assessment of Errors in the Sampling of Soils" (PDF) (65 pp, 499K, About PDF) (EPA/600/R-90/013) May 1990

General Sampling Strategies
SW 846 Manual: Test Methods for Evaluating Solid Waste, Physical/Chemical Methods.

4.7 - Water and Air Monitoring and Reporting - Sampling, Methods and Quality Assurance, Ministry of Environment - Government of British Columbia

Environmental Monitoring, Reporting & Economics
Sampling, Methods and Quality Assurance
British Columbia Field Sampling Manual: 2013 – For Continuous Monitoring and the Collection of Air, Air-Emission, Water, Wastewater, Soil, Sediment and Biological Samples
Last Updated: October 2013

http://www.env.gov.bc.ca/epd/wamr/labsys/field-sampling-manual/

The following text was taken from Water and Air Monitoring and Reporting - Sampling, Methods and Quality Assurance, Ministry of Environment - Government of British Columbia :

The 2013 edition of the British Columbia Field Sampling Manual sets out the sampling procedures, protocols and equipment that permittees are normally expected to use when doing monitoring required by the Ministry of Environment.

The Field Sampling Manual is available in PDF. It can be viewed in its entirety or, because of the large size of the file, in eight smaller sections for ease of access:

British Columbia Field Sampling Manual (complete) (PDF/2.34 MB)

Part A: Quality Control and Quality Assurance (PDF/164 KB)

Part B: Air and Air Emissions Testing (PDF/372 KB)

Part C: Biological Testing (PDF/514 KB)

Part D: Soil and Sediment Sampling (PDF/260 KB)

Part E: Water and Wastewater Sampling (PDF/891 KB)

For More Information:

Environmental Quality Branch
Ministry of Environment
Government of British Columbia
PO Box 9341
Stn Prov Govt
Victoria, British Columbia
Canada V8W 9M1

4.8 - Free DQO-PRO Calculator and an Accompanying Inexpensive Tutorial

Instant Reference Sources, Inc.
Dr. L. H. Keith

http://www.instantref.com/tutorial.htm

The following text is from the Free DQO-PRO Calculator and an Accompanying Inexpensive Tutorial:

Instant Reference Sources, Inc. is pleased to provide you with a free copy of DQO-PRO as well as inexpensive software in the form of a PowerPoint tutorial to help you obtain the best use from your DQO-PRO software.

DQO-PRO was designed to help specifically with the "Optimize Design" step of EPA's Data Quality Objectives (DQO) process. The DQO process is a structured way to plan data collection efforts. It was developed by the U.S. EPA Quality Assurance Management Staff (QAMS) to help decision makers define the specific questions that a data collection effort is intended to answer, identify the decisions that will be made using the data, and define the allowable risk of decision errors in specific, quantitative terms. DQO-PRO will help you to quickly determine the confidence levels in your data based on the number of samples you are analyzing or to help you determine how many samples you would need to analyze in order for you to achieve your data quality goals.

5.0 Quality Control and Uncertainty due to Sampling

"How much error can you tolerate for the purpose of your study"? How bad does the data have to be to be useless?

Man walked into my lab and said "Analyse this, it is a core sample"
I said how come it doesn't look like a core sample?
It's January, idiot, I couldn't get the sampler into the ground so I scraped up what I could and put it in a bottle. Analyse this!

Man says "We remediated that contaminated site and it is now clean. Your lab said so based on the above sample."

5.1 - Statistical Methods in Water Resources, Book 4, Hydrologic Analysis and Interpretation

Chapter A3
Statistical Methods in Water Resources
By D.R. Helsel and R.M. Hirsch
U.S.DEPARTMENT OF THE INTERIOR GALE A. NORTON, Secretary
U.S.GEOLOGICAL SURVEY Charles G. Groat, Director
September 2002

http://www.cala.ca/sampling/40_Statistical_Methods_in_Water_Resources.pdf

The following text was taken from Statistical Methods in Water Resources:

Preface
This book began as class notes for a course we teach on applied statistical methods to hydrologists of the Water Resources Division, U. S. Geological Survey (USGS). It reflects our attempts to teach statistical methods which are appropriate for analysis of water resources data. As interest in this course has grown outside of the USGS, incentive grew to develop the material into a textbook. The topics covered are those we feel are of greatest usefulness to the practicing water resources scientist. Yet all topics can be directly applied to many other types of environmental data.

This book is not a stand-alone text on statistics, or a text on statistical hydrology. For example, in addition to this material we use a textbook on introductory statistics in the USGS training course. As a consequence, discussions of topics such as probability theory required in a general statistics textbook will not be found here. Derivations of most equations are not presented. Important tables included in all general statistics texts, such as quantiles of the normal distribution, are not found here. Neither are details of how statistical distributions should be fitted to flood data -- these are adequately covered in numerous books on statistical hydrology.

We have instead chosen to emphasize topics not always found in introductory statistics textbooks, and often not adequately covered in statistical textbooks for scientists and engineers. Tables included here, for example, are those found more often in books on nonparametric statistics than in books likely to have been used in college courses for engineers. This book points the environmental and water resources scientist to robust and nonparametric statistics, and to exploratory data analysis. We believe that the characteristics of environmental (and perhaps most other 'real') data drive analysis methods towards use of robust and nonparametric methods.

5.2 - Guidelines for Quality Assurance and Quality Control in Surface Water Quality Programs in Alberta

Alberta Environment
July 2006

Pub. No: T/884
ISBN: 0-7785-5081-8 (Printed Edition)
ISBN: 0-7785-5082-6 (On-line Edition)

http://www.cala.ca/sampling/18_Guidelines_for_Quality_Assurance_and_Quality_Control_in_Surface_Water_Quality_Programs.pdf

The following text was taken from the Guidelines for Quality Assurance and Quality Control in Surface Water Quality Programs in Alberta:

PREFACE
The following document responds to the need to standardize quality assurance programs for all surface water quality studies conducted by and for the Alberta government. Although the document focuses on surface water and sediments, the principles would be similar for monitoring of groundwater, drinking water and other environmental studies.

Very few similar documents are available in Canada. In the United States, the U.S. Environmental Protection Agency has extensive and detailed documents on quality assurance, mainly because any studies using federal funding are legally bound to follow quality assurance procedures.

Much of this guideline document is based on several literature sources. It should be remembered that in the field of quality assurance, very little is set in stone, and quite often one literature source contradicts another. Therefore, Alberta Environment decided to draft its own QA/QC guidelines, which professional staff agreed upon. This document should be reviewed and updated periodically as new information becomes available.

SAMPLING PROGRAM DESIGN
For many environmental studies, the planning, design and documentation of the sampling program is the most neglected area, with insufficient time allocated to it. But sampling program design is fundamental to quality assurance. A study must be carefully planned so that the resulting data are technically and scientifically sound, and to avoid waste of resources and time. As well, the design should include feedback loops to correct problems and make sure that the data are good enough for the objectives of the study. The key quality assurance question is, “How much error can you tolerate for the purpose of the study”?

An important aspect of any water or sediment sampling program is whether the data are representative of the water body being sampled. This is addressed through the sampling design. If a sampling design results in the collection of non-representative data, even the highest quality laboratory data are not valid for answering the problem at hand (USEPA 2002c).

5.3 - Quality Control Manual for Field Measurements

ISSN 0283-7234
NT TECHN REPORT 581
Approved 2005-04

Nordic Innovation Centre
Holbergs gate 1
N-0166 Oslo
Norway

Report Internet address:
www.nordicinnovation.net

http://www.cala.ca/sampling/24_NT_TR_581_Quality_control_manual_for_Field_measurements_Nordtest_Technical_Report.pdf

The following text was taken from the Quality Control Manual for Field Measurements:

Abstract:
Field measurements are widely used in investigations on contaminated sites as alternatives to and supplementing analysis in chemical laboratories. The requirements for measurement quality and quality control of field measurements are less stringent than those for laboratory analysis. The present manual provides an introduction to the concepts and calculations of analytical quality control, a set of quality requirements for field measurements for different purpose and intended use of the measurements, a selection of quality control methods selected to be of practical use and supply the quality information required in site investigations and a set of examples demonstrating the practical use of the manual. Statistical factors and control charts are included as appendices.

5.4 - Uncertainty from Sampling – A Nordtest Handbook for Sampling Planners on Sampling Quality Assurance and Uncertainty Estimation

BASED UPON THE EURACHEM INTERNATIONAL GUIDE
ESTIMATION OF MEASUREMENT UNCERTAINTY ARISING
FROM SAMPLING
ISSN 0283-7234

Report Internet address:
info@nordicinnovation.net
www.nordicinnovation.net

Nordic Innovation Centre
Stensberggata 25
NO-0170 OSLO
Norway
info@nordicinnovation.net

http://www.cala.ca/sampling/25_NT_TR_604_Uncertainty_from_sampling_A_NORDTEST_handbook.pdf

The following text was taken from Uncertainty from Sampling – A Nordtest Handbook for Sampling Planners on Sampling Quality Assurance and Uncertainty Estimation:

Abstract:
The handbook provides practical guidance on sampling uncertainty estimation in the Nordtest TR handbook format. The handbook is an extract of and based upon the principles, methods and text of the international Eurachem Guide Estimation of measurement uncertainty arising from sampling. The Eurachem guide is more extensive and provides details on theory and additional examples. The basic reference for the text in this handbook is the above-mentioned Eurachem guide.

The overall purpose of this handbook has been to provide those working with investigations, monitoring and control that require sampling with a set of tools for calculation and control of the sampling uncertainty of their sampling procedure. Four examples illustrate the application of different methods and tools, while allowing you to follow all steps of the calculations. Although the examples are given for specific matrices (groundwater, iron ore, baby food and wastewater) the approaches are widely applicable.
It is the intention of the project group to make these tools and the understanding of their use available outside the world of analytical chemistry, although the basic principles applied originate from analytical chemistry.

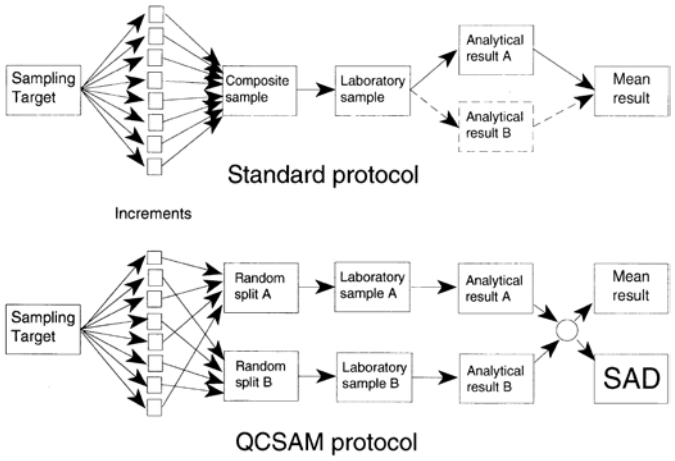
5.5 - Quality control of sampling: Proof of concept

Michael Thompson, Barry J. Coles and Joseph K. Douglas
The Analyst, 2002, 127, 174–177

http://www.cala.ca/sampling/31_Qual_control_of_sampling.pdf

The following text was taken from the Quality control of sampling: Proof of concept paper:

Quality control in sampling has been demonstrated as practicable in sampling procedures that require the combination of sample increments to form a composite sample. The proposed method requires no sampling resources or use of time beyond those normally used. Increments are allocated at random into two half-sized composites, each of which is analysed separately. The absolute difference between the two results is plotted on a one-sided control chart, which is interpreted like a Shewhart chart. In commonly prevailing circumstances the analytical precision is negligible and the chart represents sampling precision alone.



5.6 - Guidance on Environmental Data Verification and Data Validation

EPA QA/G-8
U.S. EPA
Quality Staff (2811R)
1200 Pennsylvania Avenue, NW
Washington, DC 20460

http://www.epa.gov/quality/qs-docs/g8-final.pdf

The following text was taken from the Guidance on Environmental Data Verification and Data Validation document:

PURPOSE AND OVERVIEW
A primary goal of the U.S. Environmental Protection Agency's (EPA's) Agency-Wide Quality System is "to ensure that environmental programs and decisions are supported by data of the type and quality needed and expected for their intended use...." (EPA Quality Manual for Environmental Programs, EPA Order 5360 A1) (EPA, 2000a). Accomplishment of this goal involves a set of activities conducted during the planning, implementation, and assessment phases of an environmental data collection project.

As used in this guidance, environmental data collection refers primarily to the sampling and analysis of environmental media. Though the main emphasis is on the collection of environmental samples and their analysis in a chemistry laboratory, many of the principles and practices described in this document are applicable to related measurement activities, such as bioassays, air monitoring, collection and use of geospatial data, and spatial data processing. The guidance does not address the collection or evaluation of other categories of data (economic, demographic, etc.) that play a role in evironmental decision making, nor does it directly address the evaluation of secondary data (i.e., peviously collected data compiled in EPA or other data sets).

5.7 - Measurement uncertainty arising from sampling: A guide to methods and approaches (2007)

Produced jointly by
Eurachem, EUROLAB, CITAC, Nordtest and the RSC Analytical Methods
Committee
Editors
Michael H Ramsey (University of Sussex, UK)
Stephen L R Ellison (LGC, UK)

http://www.eurachem.org/index.php/publications/guides/musamp

The following text was taken from Measurement uncertainty arising from sampling:

Summary
This Guide aims to describe various methods that can be used to estimate the uncertainty of measurement, particularly that arising from the processes of sampling and the physical preparation of samples. It takes a holistic view of the measurement process to include all of these steps as well as the analytical process, in the case where the measurand is defined in term of the value of the analyte concentration in the sampling target, rather than in just the sample delivered to the laboratory. The Guide begins by explaining the importance of knowing the total uncertainty in a measurement for making reliable interpretation of measurements, and judging their fitness for purpose. It covers the whole measurement process, defining each of the component steps, and describing the effects and errors that cause uncertainty in the final measurement.

Two main approaches to the estimation of uncertainty from sampling are described.

The empirical approach uses repeated sampling and analysis, under various conditions, to quantify the effects caused by factors such as the heterogeneity of the analyte in the sampling target and variations in the application of one or more sampling protocols, to quantify uncertainty (and usually some of its component parts). The modelling approach uses a predefined model that identifies each of the component parts of the uncertainty, making estimates of each component, and sums them in order to make an overall estimate. Models from sampling theory can sometimes be used in this approach to estimate some of the components from a knowledge of the characteristics of particulate constituents.

Worked examples are given of each of these approaches, across a range of different application areas. These include investigations of the environment (of soil and water), of food (at growing and processing) and of animal feed. The estimates of the total uncertainty of measurement range from a few per cent up to 84% relative to the measurand. The contribution of the sampling is occasionally small but is often dominant (>90% of the total measurement variance). This suggests an increased proportion of the expenditure needs to be aimed at the sampling, rather than the chemical analysis, if the total uncertainty needs to be reduced in order to achieve fitness for purpose.

Management issues addressed include the responsibility of the quality of the whole measurement process, which needs to include the sampling procedure. Guidance is given on the selection of the most appropriate approach for any application, and whether one initial validation of the system is sufficient, or whether there is a need for ongoing monitoring of the uncertainty from sampling using quality control of sampling. The extra cost of estimating uncertainty is also considered in relation to the cost savings that can be made by knowing the uncertainty of measurement more reliably.

Such a Guide can never be fully comprehensive, and although there are appendices with details of some of the statistical techniques employed and sources of more detailed advice, there will often be a need for expert advice in more complex situations. This Guide aims to be a useful introduction to this subject, but we hope it will also stimulate further research into improved methods of uncertainty estimation.

5.8 - Use of uncertainty information in compliance assessment. (2007) EURACHEM/CITAC Guide:

First edition 2007
Editors
S L R Ellison (LGC, UK)
A Williams (UK)

http://www.eurachem.org/index.php/publications/guides/uncertcompliance

The following text was taken from the Use of uncertainty information in compliance assessment:

Content
In order to decide whether a result indicates compliance or non-compliance with a specification, it is necessary to take into account the measurement uncertainty associated with the result. This guide provides guidance on how uncertainty may be taken into account in deciding compliance with a limit.

The guide is applicable to decisions on compliance with regulatory or manufacturing limits where a decision is made on the basis of a measurement result accompanied by information on the uncertainty associated with the result. It covers cases where the uncertainty does not depend on the value of the measurand, and cases where the uncertainty is proportional to the value of the measurand.

The guide includes a discussion and general recommendations, followed by more detailed instructions on establishing rules for interpretation and by several examples.

5.9 - Imperative of Good Sampling Practice (GSP) in GMO Inspection

Francis Pitard Sampling Consultants, LLC

Your Decisions are only as good as your samples!

http://www.cala.ca/sampling/59_Imperative_of_Good_Sampling_Practice_in_GMO_Inspection.pdf

This document is a presentation on how to apply Pierre Gy`s sampling theory to GMO Inspection. He discusses large and small scale variability, sampling of large shipments of products such as 2500 ton lots of cereal, sampling distributions and various types of sampling equipment. He discusses how to ensure that small scale variability or Fundamental Sampling Error (FSE) is not confused with large scale variability which means taking composite samples of 100 ton lots of the cereal particularly during sampling for regulatory purposes.

5.10 - A Rationale for the Assessment of Errors in the Sampling of Soils

US Environmental Protection Agency
ENVIRONMENTAL MONITORING SYSTEMS LABORATORY
OFFICE OF RESEARCH AND DEVELOPMENT
U.S. ENVIRONMENTAL PROTECTION AGENCY
LAS VEGAS, NEVADA 89193

National Service Center for Environmental Publications (NSCEP)

http://www.epa.gov/oust/cat/rational.pdf

The following text was taken from A Rationale for the Assessment of Errors in the Sampling of Soils:

Introduction:
The four principal contributions of this document are as follows:

1. A list of name and descriptions of quality assessment samples.
2. A rationale for determining the number of quality assessment samples to employ in a study.
3. A description of the function of various quality assurance samples in determining estimates of components of measurement error variance and
4. A basis for the development of a computer program for the computation of components of measurement error variance.

5.11 - Pierre Gy's Sampling Theory and Sampling Practice. Heterogeneity, Sampling Correctness, and Statistical Process Control

Publication Date: August 3, 1993 | ISBN-10: 0849389178 | ISBN-13: 978-0849389177 | Edition: 2

http://www.amazon.com/Sampling-Practice-Heterogeneity-Correctness-Statistical/dp/0849389178

The following text was taken from the Amazon website:

Pierre Gy's Sampling Theory and Sampling Practice, Second Edition is a concise, step-by-step guide for process variability management and methods. Updated and expanded, this new edition provides a comprehensive study of heterogeneity, covering the basic principles of sampling theory and its various applications. It presents many practical examples to allow readers to select appropriate sampling protocols and assess the validity of sampling protocols from others. The variability of dynamic process streams using variography is discussed to help bridge sampling theory with statistical process control. Many descriptions of good sampling devices, as well as descriptions of poor ones, are featured to educate readers on what to look for when purchasing sampling systems.

The book uses its accessible, tutorial style to focus on professional selection and use of methods. The book will be a valuable guide for mineral processing engineers; metallurgists; geologists; miners; chemists; environmental scientists; and practitioners in chemical, cement, steel, power generation, high performance materials, recycling, cereal, and pharmaceutical industries.

5.12 - Summary and Evaluation of Pesticides in Field Blanks Collected for the National Water-Quality Assessment Program, 1992–95

By Jeffrey D. Martin, Robert J. Gilliom, and Terry L. Schertz
National Water-Quality Assessment Program
Open-File Report 98-412
U.S. Department of the Interior
U.S. Geological Survey

http://water.usgs.gov/nawqa/pnsp/pubs/files/ofr98412.pdf

The following text was taken from the Summary and Evaluation of Pesticides in Field Blanks report:

Abstract
Field blanks are quality-control samples used to assess contamination in environmental water samples. Contamination is the unintentional introduction of a chemical (pesticides in this instance) into an environmental water sample from sources such as inadequately cleaned equipment, dirty hands, dust, rain, or fumes. Contamination causes a positive bias in analytical measurements that may need to be considered in the analysis and interpretation of the environmental data. Estimates of pesticide contamination in environmental water samples collected for the National Water-Quality Assessment (NAWQA) Program are used to qualify, where needed, interpretations of the occurrence and distribution of pesticides in the surface and ground waters of the United States.

Field blanks collected from 1992 to 1995 as part of the NAWAQA Program were analyzed for 88 pesticides and pesticide metabolites. Of 47 pesticides determined by gas chromatography/mass spectrometry, 23 were detected at least once in 175 surfacewater field blanks and 15 were detected at least once in 145 ground-water field blanks. The most frequently detected pesticides in surface-water field blanks were atrazine (in 10.9 percent of blanks), simazine (9.1 percent), and metolachlor (4.6 percent). The most frequently detected pesticides in ground-water field blanks were p,p'-DDE (4.1 percent) and atrazine (2.8 percent).

5.13 - Data Quality Assessment: Statistical Methods for Practitioners

EPA QA/G-9S
Quality Staff (2811R)
U.S. Environmental Protection Agency
1200 Pennsylvania Avenue, NW
Washington, DC 20460

http://www.epa.gov/quality/qs-docs/g9s-final.pdf

The following text was taken from the Data Quality Assessment: Statistical Methods for Practitioners document:

INTRODUCTION
Data Quality Assessment (DQA) is the scientific and statistical evaluation of environmental data to determine if they meet the planning objectives of the project, and thus are of the right type, quality, and quantity to support their intended use. DQA is built on a fundamental premise: data quality is meaningful only when it relates to the intended use of the data. This guidance describes the technical aspects of DQA in evaluating environmental data sets. A conceptual presentation of the DQA process is contained in Data Quality Assessment: A Reviewer's Guide (EPA QA/G-9R) (U.S. EPA 2004).

By using DQA, a reviewer can answer four important questions:
1. Can a decision (or estimate) be made with the desired level of certainty, given the quality of the data?
2. How well did the sampling design perform?
3. If the same sampling design strategy is used again for a similar study, would the data be expected to support the same intended use with the desired level of certainty?
4. Is it likely that sufficient samples were taken to enable the reviewer to see an effect if it was really present?

6.0 Sampling Equipment

Laboratory testing data and the resulting decisions made about the sampling target are only as good as the sample taken and that in turn depends on the use of adequate sampling equipment be it for grab or for automated samplers. Important considerations include:

- *Elimination of cross-contamination by the use of dedicated or single-use sampling devices*
- *Cleaning of the equipment if it is to be reused*

- *Calibration of field sampling equipment particularly for temperature, timing and flow rate for automated samplers*
- *Verification that the increments (individual portion of material collected by a single operation of a sampling device) for flow proportioned or time proportioned samplers are correct and the autosampler is operating as expected*
- *Protocols for filtration and minimal VOC losses during sampling*
- *Identifying individual sample locations and depths and proper location of the intake of the autosampler*

Detailed requirements for sampling equipment will depend on what is being sampled be it air, water or solids and it will depend on regulatory or contractual issues. For more information see section 10 of this document for sampling of various matrices.

6.1 - Addendum to Handbook for Sampling and Sample Preservation of Water and Wastewater, EPA-600/4-82-029

EPA-600/4-82-039\August 1983

http://www.cala.ca/sampling/2_addendum_to_sampling.pdf

This addendum provides information on automatic sampling equipment of the day.

7.0 From the Field to the Laboratory

Once the representative sample has been identified and collected, the sample must be placed in the correct container, preserved properly, held at the correct temperature and transmitted to the laboratory in time for the laboratory to start the analytical test before the sample times out. In some cases the sample handling requirements required by different bodies are different.

7.1 - BC MOE Sample Preservation & Holding Time Requirements, BC MOE, Version: 10-Feb-2011

http://www.cala.ca/sampling/33_sample-pres-dup-hold-times-BCMOE.pdf

This table contains information on BC sampling and holding time requirements including:

Parameter Name
Sample Container
Storage
Temp Preservation
Holding Time (days)
References

7.2 - A study of techniques for the preservation of mercury and other trace elements in water for analysis by inductively coupled plasma mass spectrometry (ICP-MS).

Anal. Methods, 2012, 4, 522.
Honway Louie, Choon Wong, Yi Jian Huang and Susan Fredrickson. 2011.

http://pubs.rsc.org/en/content/articlelanding/2012/ay/c2ay05182f#!divAbstract

The following text was taken from the CALA newsletter December 2013:

Laboratories accredited for mercury in water analysis - take note! Both the British Columbia Ministry of Environment (BC MOE) and Ontario Ministry of Environment (MOE) have made regulatory changes with respect to the sample container and preservation requirements for mercury analysis of waters.

In an update to Ontario MOE Reg. 153/04, the Ontario Ministry of Environment has directed that groundwater samples for dissolved mercury must be field-filtered, collected in Teflon or glass containers, and preserved with hydrochloric acid (HCl). Similarly, BC MOE now requires samples for mercury analysis to be collected in either glass or Teflon and preserved with HCl or BrCl (bromine monochloride).

The following text was taken from A study of techniques for the preservation of mercury and other trace elements in water for analysis by inductively coupled plasma mass spectrometry:

The storage of aqueous solutions in high density polyethylene (HDPE) bottles containing nitric acid (0.15 to 2.0% (v/v) was shown to be unsuitable for the preservation of dissolved mercury (Hg2+) either as a single element or as part of a multi-element solution. At concentrations ranging from 0.05 to 10.0 ug l−1 more than 10% of the dissolved mercury was lost within the first three days and up to 50% of the mercury was lost within nine days after solutions were prepared. However mercury was stable in the presence of hydrochloric acid (HCl) or sodium chloride (NaCl). Solutions of either 40 mg l−1NaCl in 0.15% (v/v) nitric acid (HNO3) or 0.01% (v/v) HCl in 1% (v/v) HNO3 were found to be effective for preserving mercury for more than 50 days. The stabilising mechanism is most likely the formation of HgCl42− complex ions that prevent the adsorption of mercury on the inner walls of the HDPE container. The elements Al, Ag, As, Ba, B, Cd, Cr, Co, Cu, Mn, Mo, Ni, Pb, Sb, Se, Tl, V and Zn were stable up to 12 months when preserved in 1.0 to 2.0% (v/v) nitric acid or a mixture of 1% (v/v) HNO3 plus 0.01% (v/v) HCl. The recommended acid combination for the preservation of mercury and multi-elements for the simultaneous determination by ICP-MS is 1% (v/v) HNO3 plus 0.01% (v/v) HCl. Chloride related polyatomic interferences in ICP-MS determination from this acid mixture were less than 0.1 ugl−1 for all elements investigated, making it an ideal preservation medium for ICP-MS analysis.

7.3 - Assessment of the Effects of Holding Time on Various Water Quality Parameters

Government of Newfoundland & Labrador
Department of Environment and Conservation
Water Resources Management Division
St. John’s, NL, A1B 4J6
Canada
June 2010

http://www.cala.ca/sampling/19_holding_times_in_water_stability_study_2009.pdf

The following text was taken from the Assessment of the Effects of Holding Time on Various Water Quality Parameters:

ABSTRACT
The Department of Environment and Conservation in Newfoundland and Labrador has identified that many of the water samples that are shipped to the National Laboratory for Environmental Testing in Burlington, Ontario are exceeding parameter holding times as prescribed by NLET's Schedule of Services. There is concern that the integrity of data is being compromised as a result of holding time exceedences. Ten parameters were identified as consistently failing to meet recommended holding times: total nitrogen, nitrate, total phosphorus, dissolved inorganic carbon, dissolved organic carbon, alkalinity, pH, specific conductivity, turbidity and color. This study was conducted to determine if the length of holding time has a significant effect on the concentration or level of any of the identified parameters. Water samples were collected from three water bodies in the province and the samples were analyzed at five different holding times. The study was conducted in two phases; the first phase of sampling was conducted in March 2009, and the second phase was conducted in October 2009, to observe whether or not seasonality had any effect on parameter concentrations at each holding time. The results of the study indicated that although parameter concentrations varied at different levels of holding time, none of the differences were significant at 0.05. This study is of particular relevance to the province of Newfoundland and Labrador because the results indicate that although recommended holding times cannot always be met, the analysis results for the ten parameters of interest are valid and representative of true water quality. Notwithstanding this conclusion, water samples should always be analyzed as soon as possible after collection.

7.4 - APHA Standard Methods, Collection and Preservation of Samples, Table 1060:I

Summary of Special Sampling and Handling Requirements

http://www.standardmethods.org/

https://www.google.ca/#q=APHA+Method+1060%2C+%E2%80%9CCollection+and+Preservation+of+Samples

The following text was taken from the APHA Standard Methods, Collection and Preservation of Samples, Table 1060:I

1060 COLLECTION AND PRESERVATION OF SAMPLES
1060 A. Introduction
It is an old axiom that the result of any testing method can be no better than the sample on which it is performed. It is beyond the scope of this publication to specify detailed procedures for the collection of all samples because of varied purposes and analytical procedures. Detailed information is presented in specific methods. This section presents general considerations, applicable primarily to chemical analyses. See appropriate sections for samples to be used in toxicity testing and microbiological, biological, and radiological examinations.

The objective of sampling is to collect a portion of material small enough in volume to be transported conveniently and yet large enough for analytical purposes while still accurately representing the material

being sampled. This objective implies that the relative proportions or concentrations of all pertinent components will be the same in the samples as in the material being sampled, and that the sample will be handled in such a way that no significant changes in composition occur before the tests are made.

Frequently the objective of sampling and testing is to demonstrate whether continuing compliance with specific regulatory requirements has been achieved. Samples are presented to the laboratory for specific determinations with the sampler being responsible for collecting a valid and representative sample.

Because of the increasing importance placed on verifying the accuracy and representativeness of data, greater emphasis is placed on proper sample collection, tracking, and preservation techniques. Often, laboratory personnel help in planning a sampling program, in consultation with the user of the test results. Such consultation is essential to ensure selecting samples and analytical methods that provide a sound and valid basis for answering the questions that prompted the sampling and that will meet regulatory and/or project-specific requirements.

This section addresses the collection and preservation of water and wastewater samples; the general principles also apply to the sampling of solid or semisolid matrices.

7.5 - Sample Holding Time Reevaluation

EPA/600/R-05/124
October 2005
www.epa.gov

Prepared for
U.S. Environmental Protection Agency
National Exposure Research Laboratory
Environmental Sciences Division
944 East Harmon Avenue
Las Vegas, Nevada 89119

Prepared by
Battelle Memorial Institute
Pacific Northwest Division
Post Office Box 999
Battelle Boulevard
Richland, Washington 99352
C.C. Ainsworth, V.I. Cullinan, E.A. Crecelius, K.B. Wagnon, and L.A. Niewolny
U.S. Environmental Protection Agency
Office of Research and Development
Washington, DC 20460

http://www.cala.ca/sampling/64_bs_033cmb06.pdf

The following text is the Executive Summary to the Sample Holding Time Reevaluation report:

Executive Summary

The project's overall objective was to investigate the stability of selected contaminants in soil/sediment samples as a function of holding time prior to extraction. Contaminants of interest centered on SVOCs; particularly polyaromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), and pesticides, Cr(VI), and several heavy metals. Contaminant specific objectives were:

1. Determine if selected SVOC contaminant concentrations in soil/sediment changed with time when held in storage beyond their established extraction maximum holding times (MHTs) under current preservation techniques and at -20°C;

2. Determine if Cr(VI) concentrations change when held in storage beyond their established MHTs under current preservation techniques and at -20°C;

3. Determine if extracted Cr(VI) concentrations change when held beyond the analysis MHT (24-h) when held in the dark at room temperature (~20°C) or 4°C;

4. Determine if air-drying soil samples will adversely impact hot acid extractable heavy metal concentrations.

Test soils/sediments from contaminated sites were identified, collected and homogenized prior to extraction by SW-846 methods. After homogenization, soil/sediment samples were stored under designated conditions and extracted at multiples of the current MHT (depending on the contaminant, multiples of MHT were between 0.5 and 12). Analyses of contaminant concentrations were performed in accordance with SW-846 methodologies. Results of these extractions were evaluated by a progression of four distinct analyses to elucidate possible decreases in concentration of an analyte (lines of evidence). First, the magnitude and variability of the concentration was used to suggest a level of the signal to noise ratio; second, a t-test of the H_0 :overall mean equal to or greater than the Day 0 mean was used to provide a level of relevance to observed change; third, a regression against time was used to estimate a rate of change; and fourth, a nonparametric upper and lower bound based on the Day 0 quartiles was used to provide an alternative measure of relevance to the potential change through time. Ultimately; however, linear regression analysis was utilized to estimate the time required to observe a specific percent change in the extractable concentration.

The estimated number of days until a 5% decrease in Cr(VI) concentration from the estimated intercept would be observed was greater than 140 days for all sediments/soils tested. The results of this study suggest that the recoveries of matrix spike and control extracts are key to determining stability of Cr(VI) in the solid materials to be extracted and the extracts themselves. In all cases, when the recovery of the matrix spike and control samples was good (within acceptable parameters), the stability of Cr(VI) in the sediment/soil and extract solutions (stored under proper conditions) appear to be longer than the current MHT specified in SW-486.

For the 17 PAH compounds that were quantified in three different soils/sediments, a holding time of 100 days at either 4^{o}C or -20^{o}C would result in no more than a 20% decrease in concentration. Importantly, there is considerable variability in the estimated holding times for different compounds and in different soils/sediments. The major consideration in sediment holding time appears, from these studies, to be the number of aromatic rings (or molecular weight) of the PAH of interest. Only the Eagle Harbor soil appeared

to have significant loss to PAHs for samples stored at 4°C as compared to samples stored at -20°C. The loss of up to 50% occurred for compounds with relatively low molecular weights, including acenaphthene, fluorene, dibenzothiophene, phenanthrene and anthracene. These results confirmed a previous study that demonstrated freezing sediment/soil reduced the loss of low molecular weight (low number of rings) PAHs.

For the three PCB Aroclor mixtures and the seven congeners that were quantified in three different soils/sediments, a holding time of 260 days at 4°C and 281 days at -20°C would result in not more than a 20% decrease in concentration. An indication of the stability of the PCBs in the three soil/sediments that were studied is the very small difference in the mean concentration for all data across time at two storage temperatures. In almost every case, the concentrations for the -20°C samples are slightly greater, about 10% or less, than for the 4°C mean. This could be interpreted that about 10% more PCBs are lost during the 5.6 month storage time at 4°C than at - 20°C. Given the 25% coefficient of variation (CV) metric for replicate precision; however, it is unlikely that this 10% difference could be accurately quantified.

For the 10 pesticides that were quantified in four different soils/sediments, a holding time of 217 days at 4°C and 299 days at -20°C would result in not more than a 20% decrease in concentration. These holding times are far greater than the current MHT specified in SW-846. In almost every case, the mean concentrations for the -20oC samples are within a few percent of the 4oC mean. This could be interpreted as less than 5% of the pesticides studied are lost during the 5.6 month storage time of samples at 4°C compared to storage at - 20°C.

Extractable metal concentrations were not effected significantly by a holding time of up to 364 days or by the air drying treatment. All data sets exhibited fairly tight CVs across the holding times. The CV data suggests that no chemically significant change in concentration occurred during the 364 day holding time and the pooled data exhibited no significant difference between moist or dry sample handling. These results suggest that it would take a minimum of 709 days before the acid-extractable As, Cu, Pb, or Zn concentration would be reduced by 20%.

8.0 Operator Training, Documentation and Field Notes

Many provincial and national jurisdictions have Operator Certification programs and other educational materials for water and wastewater systems. Some are based on programs from California and Ohio but there may be specific requirements depending on the jurisdiction.

8.1 - Industrial Wastewater (Pre) Treatment Operator Certification Program

EXAM STUDY GUIDE
FEBRUARY 2006
Ohio Water Environment Association

http://www.cala.ca/sampling/5_2013_Sampling_Protocol.pdf

The following text was taken from the Ohio Industrial Wastewater (Pre) Treatment Operator Certification Program document:

The purpose of this study guide is to help prepare an individual for the Industrial

Wastewater Treatment Operator Certification exam offered by the Ohio Water Environment Association (OWEA).

What is an Industrial Wastewater (Pre)Treatment Operator Certification? It is a voluntary certification available to any operators or supervisors of an industrial wastewater treatment or pretreatment system within the state of Ohio. Certification is being offered by the OWEA to further the organization's goal or improving water quality within Ohio and furthering the knowledge of individuals engaged in the wastewater treatment industry. Certification is offered to those individuals that have the education, experience, and can successfully display on an exam some of the pertinent knowledge required to operate an industrial wastewater (pre)treatment system as determined by the OWEA's Board of Industrial Wastewater (Pre)Treatment Operator Certification (the Board).

8.2 - California State University - Sacramento Operator Training Program

Course Work for Examinations for Wastewater Operators, Collection System Operators, Water Plant Operators and Distribution System Operators

http://www.owp.csus.edu/courses/catalog.php

http://www.owp.csus.edu/courses/wastewater.php

http://www.owp.csus.edu/courses/drinking-water.php

This describes a series of training courses for operators of water and wastewater facilities. Many of the training courses involve sampling of the various processes.

The following text was taken from the California State University - Sacramento Operator Training Program website:

Operator Training Courses
The Office of Water Programs at the California State University, Sacramento, College of Engineering and Computer Science provides distance learning courses for persons interested in the operation and maintenance of drinking water and wastewater facilities. These training programs were developed by people who explain, through the use of our manuals, how they operate and maintain their facilities. Sacramento State, fully accredited by the Western Association of Schools and Colleges, administers and monitors these training programs, under the direction of Dr. Ramzi J. Mahmood.

8.3 – Water & Wastewater Sampling Course

Continuing Education Professional Development Course
Technical Learning College
P.O. Box 420
Payson, AZ 85547-0420
April 7, 2007

http://abctlc.com/courses/SAMPLING.pdf

The following text was taken from the Technical Learning College Water & Wastewater Sampling Course:

Important Information about this Manual
This manual has been prepared to assist employees in the general awareness of water and wastewater regulatory sampling and in dealing with often-complex procedures and requirements for safely handling hazardous and toxic materials. The scope of the material is quite large, requiring a major effort to bring it under control. Employee health and safety, as well as that of the public, depend upon careful application of federal and state regulations and safe working procedures.

This manual will cover general laws, regulations, required procedures and work rules relating to water and wastewater sampling. It should be noted, however, that the federal and state regulations are an ongoing process and subject to change over time. For this reason, a list of resources and hyperlinks is provided to assist in obtaining the most up-to-date information on various subjects.

This manual is a guidance document for employees who are involved with water quality and pollution control. It is not designed to meet the full requirements of the United States Environmental Protection Agency (EPA) or the Department of Labor-Occupational Safety and Health Administration (OSHA) rules and regulations.

This course manual will provide general guidance and should not be used as a preliminary basis for developing general water/wastewater sampling plans. This document is not a detailed water/wastewater textbook or a comprehensive source book on water/wastewater rules and regulations.

8.4 – New Mexico Water Sampling Technician Certification Study Guide Version II

Utility Operator Certification Program
NMED Surface Water Quality Bureau
PO Box 5469
Santa Fe, NM 87502
www.nmenv.state.nm.
August 15, 2007
Prepared By Fred Ragsdale
Ragsdale and Associates: Training Specialists, LLC

http://www.nmenv.state.nm.us/swqb/FOS/Training/WaterSamplingStudyGuide/WaterSamplingStudyGuide.pdf

The following text was taken from the New Mexico Water Sampling Technician Certification Study Guide Version II:

This "Water Sampling Technician Certification Study Guide" has been created as a tool to assist those who collect water system samples in preparation for taking Water Sampling Technician certification exams. This book is not intended to be a complete reference manual for technical information. Its purpose is to guide the reader to study material for each of the major subject areas for Level 1 and Level 2 certification. There is no implied claim that this study guide covers every possible point on which a technician may be tested.

However, it is intended to be comprehensive in its coverage of the essential information for each exam, based on standard Need- To-Know criteria.

This study guide is divided into seven chapters. Each chapter in the study guide has study questions and sample test questions that are intended help the individual focus on the type of information that is covered in an exam. The study questions are designed to direct the reader to exam information that is related to the chapter topics. No answer sheet is provided. You will have to look them up.

The Appendix contains helpful information regarding sampling schedules and the development of sample siting plans for the system.

The material dealing with sample collection has been referenced to approved EPA methodology for sample collection and preservation. Information regarding the completion of the various sample request forms has been referenced to the New Mexico Department of Health – Scientific Laboratory Division.

8.5 – Education material on environmental sampling

Sampler education pilot project
24 Jun 2009

http://www.dhigroup.com/News/2009/06/24/ANewTextbookSeriesOnEnvironmentalSamplingInPractice.aspx

The following text was taken from the Education material on environmental sampling:

In March 2009 DHI successfully finished the sampler education pilot project within the framework of the EU Leonardo da Vinci programme under the Community Vocational Training Action Programme. DHI was the project leader of a partnership between twelve institutions in the domain of environmental consultancy and technical training.

One very important part of the educational system developed during the project is a textbook series comprising five volumes on environmental sampling. The first volume covers sampling basics and the other four volumes encompass four specific materials: sampling of waste, soil, groundwater and wastewater/sludge, respectively. All five volumes focus on the sampler's tasks and responsibilities.

The first volume provides basic knowledge about sampling, such as
Responsibilities in sampling
Reading and understanding the sampling plan
The sampling process
Major challenges in sampling
Validation and quality control
General health and safety considerations

The four other volumes follow the same basic structure and give practical guidance about:
Basic knowledge about the material to be sampled
Reading and understanding the sampling plan
Sampling methods

Sampling on site
Sample handling
Documentation
Quality and performance control
Health and safety

Project homepage
Visit the project homepage (http://www.sampler-education.dhi.eu) if you are interested in more information about the project.

Purchasing the books
The books can be purchased through DHI. Please contact Jette Bjerre Hansen, jbh@dhigroup.com for more information.

9.0 Testing in the Field

Field test kits are fast, accurate, cheap, you don't need a lab, don't need to calibrate and you get your results immediately: Manufacturers claim for field test kits. *Do not believe this claim.*

Sometimes this claim is actually true but it only works if the test kit is based on sound scientific principles, and is engineered to work well. Some field test kits work very well. Many do not.

Placing of in-situ testing probes constitutes sampling.

9.1 - Quality Control Manual for Field Measurements

ISSN 0283-7234
NT TECHN REPORT 581
Approved 2005-04

Nordic Innovation Centre
Holbergs gate 1
N-0166 Oslo
Norway
Report Internet address:

www.nordicinnovation.net

http://www.cala.ca/sampling/24_NT_TR_581_Quality_control_manual_for_Field_measurements_Nordtest_Technical_Report.pdf

The following text was taken from the Quality Control Manual for Field Measurements:

Abstract:
Field measurements are widely used in investigations on contaminated sites as alternatives to and supplementing analysis in chemical laboratories. The requirements for measurement quality and quality

control of field measurements are less stringent than those for laboratory analysis. The present manual provides an introduction to the concepts and calculations of analytical quality control, a set of quality requirements for field measurements for different purpose and intended use of the measurements, a selection of quality control methods selected to be of practical use and supply the quality information required in site investigations and a set of examples demonstrating the practical use of the manual. Statistical factors and control charts are included as appendices.

9.2 - New Approach to Geochemical Measurement

See Section 2 – Definitions for discussion of uncertainty and field testing.

9.3 - Guidelines and Standard Procedures for Continuous Water-Quality Monitors: Station Operation, Record Computation, and Data Reporting

By Richard J. Wagner, Robert W. Boulger, Jr., Carolyn J. Oblinger, and Brett A. Smith
U.S. Department of the Interior
U.S. Geological Survey
Techniques and Methods 1–D3

http://pubs.usgs.gov/tm/2006/tm1D3/pdf/TM1D3.pdf

The following text was taken from the Guidelines and Standard Procedures for Continuous Water-Quality Monitors:

Abstract
The U.S. Geological Survey uses continuous water- quality monitors to assess the quality of the Nation's surface water. A common monitoring-system configuration for water-quality data collection is the four-parameter monitoring system, which collects temperature, specific conductance, dissolved oxygen, and pH data. Such systems also can be configured to measure other properties, such as turbidity or fluorescence. Data from sensors can be used in conjunction with chemical analyses of samples to estimate chemical loads. The sensors that are used to measure water-quality field parameters require careful field observation, cleaning, and calibration procedures, as well as thorough procedures for the computation and publication of final records.

This report provides guidelines for site- and monitor-selection considerations; sensor inspection and calibration methods; field procedures; data evaluation, correction, and computation; and record-review and data-reporting processes, which supersede the guidelines presented previously in
U.S. Geological Survey Water-Resources Investigations Report 00 – 4252. These procedures have evolved over the past three decades, and the process continues to evolve with newer technologies.

10.0 Matrix Specific Sampling

Information exists for sampling of various and diverse sample matrix types.

10.1 Water and Wastewater Sampling

10.1.1 - Handbook for Sampling and Sample Preservation of Water and Wastewater

There are two related documents here – the Handbook and the Addendum to the handbook which provides information on automatic sampling equipment of the day. The Addendum is found under section 6 – Sampling Equipment.

United States Environmental Protection Agency
Environmental Monitoring and Support Laboratory, Cincinnati, OH, 45268
EPA-600/4-82-029\September 1982

http://www.cala.ca/sampling/1_Sampling_preservation_water_wastewater.pdf

The following text was taken from the Handbook for Sampling and Sample Preservation of Water and Wastewater:

ABSTRACT
The four basic factors which affect the quality of environmental data are sample collection, sample preservation, analyses, and recording. Improper actions in any one area may result in poor data from which poor judgements are certain. This manual was developed to provide general and specific guidance in sample collection and preservation.

A review of the literature and a survey of field practices provide the basis for guidelines in general sampling techniques, samplers, flow measuring devices, a statistical approach to sampling, preservation of samples for physical, chemical, biological and radiological analyses, procedures for sampling waters from municipal, industrial, and agricultural sources, surface waters, and sludges.

Finally this handbook does not supersede sampling, preservation, or chain or custody procedures specified by enforcement, compliance monitoring, or program offices of the U.S. Environmental Protection Agency. Rather it is intended to compliment their requirements.

10.1.2 - Aquatic Ecosystems Field Sampling Protocols

Prepared by:
Alberta Environment
March 2006
W0605
ISBN: 0-7785-5079-6 (Printed Edition)
ISBN: 0-7785-5080-X (On-line Edition)

Web Site: http://environment.gov.ab.ca/info/home.asp

http://www.cala.ca/sampling/8_Aquatic_Ecosystems_Field_Sampling_Protocols.pdf

The following text was taken from the Aquatic Ecosystems Field Sampling Protocols document:

1.0 INTRODUCTION
This document is one of a series of four reports containing field protocols and methods for the sampling of key components of aquatic ecosystems in Alberta (i.e., for surface water quality, surface water quantity, groundwater, and meteorology). These protocols are important to ensure that samples are collected consistently and the data obtained are accurate and scientifically sound. Given appropriate sampling protocols and study designs, the information obtained will permit the tracking of changes in surface water quality and other measures of ecosystem health over time. This will also allow for accurate comparisons of ecosystem health among different watersheds and ecoregions in Alberta.

10.1.3 - Protocols Manual for Water Quality Sampling in Canada

The Canadian Council of Ministers of the Environment (CCME)

PN 1461
ISBN 978-1-896997- 7-0 PDF

http://www.cala.ca/sampling/10_CCME_PROTOCOLS_MANUAL_FOR_WATER_QUALITY_SAMPLING_IN_CANADA.pdf

The following text was taken from the Protocols Manual For Water Quality Sampling In Canada document:

HOW TO USE THIS MANUAL

This manual is intended to help users find appropriate protocols that can be used for water quality sampling in Canada. It includes new technologies and methods such as microbial source tracking and continuous water quality monitoring, along with other established methods. The manual covers all aspects of physical, chemical and biological sampling for a variety of aquatic habitats (lakes, rivers, streams, wetlands) and biota, fish, benthos, plankton, etc).

Modifications to jurisdiction specified sampling procedures/protocols should be approved by that jurisdiction before any sampling program is undertaken. Original protocols referenced through out this manual should be consulted in order to obtain more detailed information.

1.0 INTRODUCTION
The Canadian Council of Ministers of the Environment (CCME) through the Water
Quality Task Group identified a need for water monitoring guidance. This sampling manual will provide a Canada-wide consistency in water monitoring.

10.1.4 - Protocol for the Sampling and Analysis of Industrial/Municipal Wastewater

Ontario Ministry of Environment
JANUARY 1999

http://www.cala.ca/sampling/30_PROTOCOL_FOR_THE_SAMPLING_AND_ANALYSIS_OF_INDUSTRIAL_MUNICIPAL_WASTEWATER.pdf

The following text was taken from the Protocol for the Sampling and Analysis of Industrial/Municipal Wastewater document:

PURPOSE
The purpose of this Protocol is to provide guidelines with respect to sampling, analysis and QA/QC procedures to be followed for MOE programs and to specify requirements for compliance with Effluent Monitoring and Effluent Limits Regulations. In all cases Sector Specific Regulatory Requirements take precedence over this Protocol. Reference must be made to the Regulations for specific requirements.

The MISA (Municipal and Industrial Strategy for Abatement) program was initiated with a series of sector specific monitoring regulations which referred to a common General Regulation (Effluent Monitoring Regulation, General: Ontario Regulation 695/88 as amended to 533/89). The General Regulation contained, among other things, the common requirements, guidelines, principles and protocols related to the sampling, preservation, storage and analysis of wastewater samples, the minimum numbers and types of field and laboratory quality control samples to be included and a general guideline for data recording and reporting.

SCOPE
This Protocol contains much of the same information originally presented in the General Regulation. It includes direction on techniques for sampling of industrial/municipal wastewater, preservation of samples and their storage requirements, maximum storage times allowed prior to analysis, the most appropriate and where applicable alternate preparation and instrumental analysis protocols and the type and frequencies of field and laboratory QC samples. This document represents a synthesis of best available information from organizations including the Ontario Ministry of Environment, Environment Canada, Standard Methods for the Examination of Water and Wastewater (Current edition, American Public Health Association), US Environmental Protection Agency (Federal Register CFR40 part 136). It also incorporates the recommendations and conclusions reached through collaborative efforts of government, industrial and private laboratory personnel.

10.1.5 - F-10-1 Procedures For Sampling And Analysis Requirements For Municipal And Private Sewage Treatment Works (Liquid Waste Streams Only)

Ontario Ministry of Environment

http://www.ene.gov.on.ca/environment/en/resources/STD01_076054.html

The following text was taken from F-10-1 Procedures for Sampling and Analysis:

Description: The primary purpose of the sampling and analysis program covered by Guideline F-10 is to evaluate a sewage treatment works' performance and compliance with effluent requirements. Guideline F-10 and this procedure are meant to apply to all municipal and private (non-industrial) sewage treatment works in the Province of Ontario, except for those exempted from the requirements of Section 53 of the OWR Act (R.S.O. 1990).

10.1.6 - City of Greeley Industrial Pretreatment Program

WASTEWATER SAMPLING PROCEDURES

http://www.cala.ca/sampling/6_2013_Sampling_Protocols.pdf

The following text was taken from the City of Greeley Industrial Pretreatment Program:

The analytical results of a sample are only as accurate as the quality of the sample taken.

If your technique for collecting samples is poor, then no matter how accurate your lab procedures are, the results will be poor. By sampling according to set procedures, you reduce the chance of error and increase the accuracy of your sample results.

This is a document compiled from information obtained from the Environmental Protection Agency, Water Environment Federation, Florida Dept. of Environmental Protection and ISCO Manufacturing publications. It will cover the proper methods of sampling, sample preparation, documentation and sampler cleaning.

The Six Criteria for Quality Data
1. Collecting Representative Samples
2. Formulating the Objectives Of The Sampling Program
3. Proper Handling and Preservation Of Water Samples
4. Proper Chain-Of-Custody and Sample Id Procedures
5. Field Quality Assurance
6. Proper Analysis

10.1.7 - SESD Operating Procedure - Surface Water Sampling_AF.R1

SESDPROC-201-R1
Effective Date: November 1, 2007

US Environmental Protection Agency
Science and Ecosystem Support Division
Athens, Georgia

http://www.cala.ca/sampling/41_Surface_water_Sampling_2007.pdf

The following text was taken from the Science and Ecosystem Support Division Operating Procedure:

1.1 Purpose
This document describes general and specific procedures, methods and considerations to be used and observed when collecting surface water samples for field screening or laboratory analysis.

1.2 Scope/Application
The procedures contained in this document are to be used by field personnel when collecting and handling surface water samples in the field. On the occasion that SESD field personnel determine that any of the procedures described in this section are either inappropriate, inadequate or impractical and that another

procedure must be used to obtain a surface water sample, the variant procedure will be documented in the field log book, along with a description of the circumstances requiring its use.

1.3 Documentation/Verification
This procedure was prepared by persons deemed technically competent by SESD management, based on their knowledge, skills and abilities and have been tested in practice and reviewed in print by a subject matter expert. The official copy of this procedure resides on the H: drive of the SESD local area network. The Field Quality Manager (FQM) is responsible for ensuring the most recent version of the procedure is placed on the H: drive and for maintaining records of review conducted prior to its issuance.

10.1.8 - EPB 281- Sampling Guidelines for Effluents and Receiving Waters

Saskatchewan Ministry of Environment, Water Security Agency

http://www.saskh2o.ca/DWBinder/epb281.pdf

The following text was taken from EPB 281- Sampling Guidelines for Effluents and Receiving Waters:

Sampling Procedures

1. When and Where to Sample
The requirements for when and where to sample are outlined in your current Permit to Operate a Wastewater Works. In most cases these requirements are outlined in the permit's appendices.

Generally this will require:
- sampling is to be conducted during any release of treated effluent;
- samples are normally collected midway during the lagoon discharge period. Lagoons are normally discharged twice each year; once during spring runoff and again during the fall period; and
- some permits will require samples to be collected from receiving streams. These will require samples collected upstream and downstream of the point of discharge.

2. How to Collect the Samples
- persons collecting wastewater samples should take proper protective measures including the use of proper protective gloves; wash your hands carefully with soap and water before and after collecting the sample;
- rinse the sampling containers two times with the effluent or water to be collected;
- the samples should be representative of existing conditions;
- care should be taken to avoid disturbing bottom sediments and allowing these or surface scum to enter the container; for bacteriological analysis use the sterile container. Take the cap off the sterile bottle and hold the cap in one hand. Carefully fill the bottle within 6 to 7 millimetres (1/4 inch) of the top. Replace the cap to the bottle without touching the inside of the cap or the mouth of the bottle;
- onsite tests for temperature and pH will need to be done if any samples are being collected for ammonia; and
- samples collected from the receiving streams should be collected:
  - at least 1 metre out from the shore (using a sampling rod);
  - at least 0.3 metres below the surface if sampling from a bridge: and

o samples should be collected on the upstream side.

10.1.9 - Guidelines Establishing Test Procedures for the Analysis of Pollutants Under the Clean Water Act National Primary Drinking Water Regulations; and National Secondary Drinking Water Regulations; Analysis and Sampling Procedures

US Environmental Protection Agency
40 CFR Parts 136, 260, 423, 430, and 435
[EPA–HQ–OW–2003–0070; FRL–8203–8]
RIN 2040–AD71

http://www.gpo.gov/fdsys/pkg/FR-2012-05-18/pdf/2012-10210.pdf

The following text was taken from the Guidelines Establishing Test Procedures for the Analysis of Pollutants document:

SUMMARY: This rule modifies the testing procedures approved for analysis and sampling under the Clean Water Act. EPA proposed these changes for public comment on September 23, 2010. The changes adopted in this final rule fall into the following categories: New and revised EPA methods and new and revised methods published by voluntary consensus standard bodies (VCSB), such as ASTM International and the Standard Methods Committee; updated versions of currently approved methods; methods reviewed under the alternate test procedures (ATP) program; clarifications to the process for EPA approval for use of alternate procedures for nationwide and Regional use; minimum quality control requirements to improve consistency across method versions; corrections to previously approved methods; and revisions to sample collection, preservation, and holding time requirements. Finally, EPA makes changes to three effluent guideline regulations.

10.1.10 - Trade Effluent Sampling Code of Practice, Scottish Water, Always Serving Scotland

Version: 1
Prepared by: Trade Effluent

http://www.cala.ca/sampling/49_Scottish_Water_110712_Trade_Effluent_Sampling_Code_of_Practice.pdf

The following text was taken from the Trade Effluent Sampling Code of Practice, Scottish Water document:

Trade Effluent Sampling Code of Practice
This is the Code of Practice that accompanies Schedule 5 of the template Wholesale Services Agreement (WSA), “Requirements for the provision of Trade Effluent Sampling and Analytical Services by the Licensee”. All defined terms contained within this Code of Practice refer to the terms defined in the template WSA.

This Code of Practice sets out best practice that the Licensee should observe when conducting both Trade Effluent Service (TE) A and Trade Effluent (TE) Service B.

1. Training

All staff involved in trade effluent sampling should be shown to be competent in carrying out their duties. Staff should be trained in the necessary skills, and a record of training for each individual should be maintained as part of the quality system. A programme of training updates should be detailed in the quality system.

2. Health & Safety
All sampling should be undertaken in a safe manner. Each sampling site will have a Risk Assessment form that will outline potential hazards and procedures for safe sampling. The appropriate Personal Protective Equipment (PPE) to include hard hat, safety footwear, gloves and hi-visibility coat or waistcoat, should be available and used appropriately. PPE requirements may vary from site to site.

The Licensee in carrying out sampling is responsible for complying with all associated health and safety obligations including their own health and safety and all other people affected by their activities

3. Sampling Equipment
The appropriate sampling rods or sampling cans should be used for the taking of spot/snap samples. Manhole lifting keys or mechanical lifters should be used to lift manhole covers. The condition of sampling equipment should be checked prior to each sampling run and damaged items replaced.

10.1.11 - Surface Water Collection SOP #EH-01

(Adapted from ERT/REAC SOP 2013 Rev 1.0)
SOP#EH-01, East Helena Site, Montana
September 2003

http://www2.epa.gov/sites/production/files/documents/r8-src_eh-01.pdf

The following text was taken from Surface Water Collection SOP#EH-01:

PURPOSE
This standard operating procedure (SOP) is applicable to the collection of representative surface water samples from streams, rivers, lakes, ponds, lagoons, and surface impoundments. It includes samples collected from depth, as well as samples collected from the surface. These are standard (i.e., typically applicable) operating procedures which may be varied or changed as required, dependent upon site conditions, equipment limitations or limitations imposed by the procedure. In all instances, the ultimate procedures employed should be documented and associated with the final report. Mention of trade names or commercial products does not constitute United States Environmental Protection Agency (U.S. EPA) endorsement or recommendation for us.

10.1.12 – Method 1669, Sampling Ambient Water for Trace Metals at EPA Water Quality Criteria Levels

U.S. Environmental Protection Agency
Office of Water Engineering and Analysis Division (4303)
401 M Street S.W.
Washington, D.C. 20460

July 1996

http://www.epa.gov/caddis/pdf/Metals_Sampling_EPA_method_1669.pdf

The following text was taken from Method 1669, Sampling Ambient Water for Trace Metals at EPA Water Quality Criteria Levels:

Introduction
This sampling method was designed to support water quality monitoring programs authorized under the Clean Water Act. Section 304(a) of the Clean Water Act requires EPA to publish water quality criteria that reflect the latest scientific knowledge concerning the physical fate (e.g., concentration and dispersal) of pollutants, the effects of pollutants on ecological and human health, and the effect of pollutants on biological community diversity, productivity, and stability.

Section 303 of the Clean Water Act requires states to set a water quality standard for each body of water within its boundaries. A state water quality standard consists of a designated use or uses of a waterbody or a segment of a waterbody, the water quality criteria that are necessary to protect the designated use or uses, and an antidegradation policy. These water quality standards serve two purposes: (1) they establish the water quality goals for a specific waterbody, and (2) they are the basis for establishing water quality-based treatment controls and strategies beyond the technology-based controls required by Sections 301(b) and 306 of the Clean Water Act.

In defining water quality standards, the state may use narrative criteria, numeric criteria, or both. However, the 1987 amendments to the Clean Water Act required states to adopt numeric criteria for toxic pollutants (designated in Section 307(a) of the Act) based on EPA Section 304(a) criteria or other scientific data, when the discharge or presence of those toxic pollutants could reasonably be expected to interfere with designated uses.

In some cases, these water quality criteria are as much as 280 times lower than those achievable using existing EPA methods and required to support technology-based permits. Therefore, this sampling method, and the analytical methods referenced in Table 1 of this document, were developed by EPA to specifically address state needs for measuring toxic metals at water quality criteria levels, when such measurements are necessary to protect designated uses in state water quality standards. The latest criteria published by EPA are those listed in the National Toxics Rule (57 FR 60848) and the Stay of Federal Water Quality Criteria for Metals (60 FR 22228). These rules include water quality criteria for 13 metals, and it is these criteria on which this sampling method and the referenced analytical methods are based.

In developing these methods, EPA found that one of the greatest difficulties in measuring pollutants at these levels was precluding sample contamination during collection, transport, and analysis. The degree of difficulty, however, is highly dependent on the metal and site-specific conditions. This method, therefore, is designed to provide the level of protection necessary to preclude contamination in nearly all situations. It is also designed to provide the procedures necessary to produce reliable results at the lowest possible water quality criteria published by EPA. In recognition of the variety of situations to which this method may be applied, and in recognition of continuing technological advances, the method is performance-based. Alternative procedures may be used, so long as those procedures are demonstrated to yield reliable results.

Requests for additional copies of this method should be directed to:

U.S. EPA NCEPI
11029 Kenwood Road
Cincinnati, OH 45242

10.2 Drinking Water Sampling

10.2.1 - Practices for the Collection and Handling of Drinking Water Samples, Version 2.0

Laboratory Services Branch
Ministry of the Environment
April 1, 2009
PIBS 4464e01
Ontario.ca/Environment

http://www.cala.ca/sampling/29_Practices_for_Collection_And_Handling_of_Drinking_Water_Samples.pdf

The following text was taken from the Practices for the Collection and Handling of Drinking Water Samples:

Introduction
To ensure the provision of safe drinking water to the citizens of Ontario, regulatory requirements under the Safe Drinking Water Act, 2002 govern the sampling and testing of water provided by municipal and non-municipal communal water systems. The purpose of this document is to provide guidance for the collection, labelling, storage, transportation and chain-of-custody of all drinking water samples that fall under the Drinking Water Systems Regulation (Ontario Regulation 170/03), Transitional – Small Drinking Water Systems (O Reg 318/08), Small Drinking Water Systems (O Reg 319/08), and Schools, Private Schools and Day Nurseries Regulation (O Reg 243/07). Unless specifically indicated, the term "Regulations" will be used throughout the rest of this document to refer collectively to these four Ontario regulations, which may be amended from time to time.

This document is intended to provide sampling guidance for Ministry of the Environment (MOE) Provincial Officers sampling to verify the integrity of a drinking water system's self-monitoring information or sampling in response to adverse water quality notifications. It also includes the necessary container, preservative, labelling, transportation and holding time requirements for drinking water samples being submitted to the ministry's Laboratory Services Branch (LaSB) for analysis.

These practices may be used as guidance by treatment plant owners/operators sampling to meet Ontario's environmental regulatory and approval requirements. Guidance for the sampling of plumbing for lead testing as applicable to O Reg 170/03 and O Reg 243/07 is also provided. The licensed drinking water testing laboratory may also use these procedures as a guide for developing their specific documents for the safe handling and storage of drinking water samples.

10.2.2 - Sampling Guidance for Unknown Contaminants in Drinking Water

U.S. Environmental Protection Agency

Office of Water (4601M)
1200 Pennsylvania Avenue, NW
Washington, DC 20460
EPA-817-R-08-003
FINAL – 110308

http://www.cala.ca/sampling/43_USEPA_Sampling_Guidance_for_Unknown_Contaminants_in_Drinking_Water.pdf

http://www.epa.gov/watersecurity/pubs/guide_watersecurity_samplingforunknown.pdf

The following text was taken from the Sampling Guidance for Unknown Contaminants in Drinking Water:

Introduction
Homeland Security Presidential Directive 9 (HSPD 9), in pertinent part, directed the U.S. Environmental Protection Agency (EPA) and others to "build upon and expand current monitoring and surveillance programs" to:

1. Develop robust, comprehensive, and fully coordinated surveillance and monitoring systems for water quality that provide early detection and awareness of disease, pest or poisonous agents.

2. Develop nationwide laboratory networks for water quality that integrate existing federal and state laboratory resources, are interconnected, and utilize standardized diagnostic protocols and procedures.

In response to the first task under HSPD 9, EPA proposed and initiated development of a Contaminant Warning System. Sampling and sample screening are crucial components of the Contaminant Warning System, which are addressed in this document.

The Sampling Guidance for Unknown Contaminants in Drinking Water provides comprehensive guidance that integrates recommendations for pathogen, toxin, chemical, and radiochemical sample collection, preservation, and transport procedures to support multiple analytical approaches for the detection and identification of potential contaminants in drinking water. The guidance is intended to support sampling for routine and baseline monitoring to determine background concentrations of naturally occurring pathogens, sampling in response to a triggered event, and sampling in support of remediation or decontamination efforts.

The primary intended audience of this guidance document is drinking water utilities, but it may also be a useful reference for emergency response personnel. Given the complexity of a drinking water response, the response may quickly surpass the abilities of most utilities. Utilities are likely to call upon emergency responders. This guidance document can be used to supplement a drinking water utility's emergency response plan by providing detailed recommended sampling procedures for use by utility personnel in response to a potential contamination event. The sample collection procedures described may also be used to support other monitoring activities for specific contaminants or classes of contaminants, as appropriate.

10.2.3 - A Guide to Assist Nova Scotia Municipal Water Works Develop a Comprehensive Operations Manual

Nova Scotia Environment

For more information, visit our website at
www.gov.ns.ca/nse/water
or contact:
Nova Scotia Environment
PO Box 442
Halifax, NS B3J 2P8

http://www.cala.ca/sampling/22_NS_Environment_Guide_To_Annual_Sampling_Plans.pdf

The following text was taken from the Guide to Assist Nova Scotia Municipal Water Works Develop a Comprehensive Operations Manual:

The main purpose of this document is to provide guidance to managers and operators regarding the development of an annual sampling plan for water treatment and water distribution facilities in Nova Scotia.

What is an annual sampling plan?
The annual sampling plan is a document that describes the approach that the municipal water utility will follow for all water quality monitoring. This document details how a utility will collect and monitor samples in a consistent manner during the year. Sampling plans should be developed to address compliance, process control and response monitoring, as well as monitoring recommended in the source water protection plan. In some cases, special process characterization and optimization monitoring may also be included.

Why is an annual sampling plan required?
Recognizing that safe drinking water is a core public health issue, the Nova Scotia government adopted the health-related Guidelines for Canadian Drinking Water Quality (GCDWQ) as legally binding standards in October 2000. The GCDWQ set out the basic parameters that every municipal water system should strive to achieve in order to provide the cleanest, safest and most reliable drinking water possible. By developing an annual sampling plan, the municipal water utility demonstrates that they are meeting regulatory requirements.

10.2.4 - Day Nursery Sampling Protocols for O.Reg. 243/07, City of Hamilton Environmental Lab

Public Works – Water and Wastewater
Compliance and Regulations
BCOS NUMBER: PW-WW-CR-EL-V-013

http://www.cala.ca/sampling/45_V_013_Day_Nursery_Sampling_Protocols_for_O.Reg_243-07_Issue_4.pdf

The following text was taken from the Day Nursery Sampling Protocols website:

When to Sample
- After a period of six hours or more when the plumbing is not used, if practicable, OR
- After the longest period of time when the plumbing is not used

AND
- Before the plumbing is flushed as required under O.Reg. 243/07 Sections 3 and 4

Selection of Sampling Point
- Kitchen cold water tap, if day nursery has a kitchen, OR
- A cold water tap that is commonly used to provide drinking water for consumption by children under 18 years of age
- If there is more than one tap that meets these requirements then select the one most likely to be served by lead plumbing or plumbing that contains lead solder

10.2.5 - Sampling Protocol for Lead, City of Hamilton

ENVIRONMENTAL LABORATORY – VISUAL AID – LEVEL V
O. Reg. 170/03 Sampling Protocol for Lead (Schedule 15.1)
PW-WW-CR-EL-V-012

http://www.cala.ca/sampling/46_V-012_O_Reg_170_Schedule_15.pdf

This describes the Sampling Protocol for Lead, City of Hamilton.

10.2.6 - Four sampling protocols used by Environmental and Radiation Health Sciences Directorate for sampling drinking water for Disinfection by-Products.

Exposure and Biomonitoring Division
Environmental Health Science and Research Bureau
Environmental and Radiation Health Sciences Directorate

http://www.cala.ca/sampling/48a_sampling_protocol-DBPsCALAfinal.pdf

http://www.cala.ca/sampling/48b_VOCtapwatersamplingCALAfinal.pdf

http://www.cala.ca/sampling/48c_sampling_protocol-NDMACALAfinal.pdf

http://www.cala.ca/sampling/48d_sampling_protocol-pharmaCALAfinal.pdf

10.2.7 - Introduction to Drinking Water Quality Testing

A CAWST TRAINING MANUAL
June 2009 Edition

Centre for Affordable Water and Sanitation Technology
12, 2916 – 5th Avenue
Calgary, Alberta
T2A 6K4, Canada
E-mail: cawst@cawst.org
Website: www.cawst.org

http://www.cala.ca/sampling/9_CAWST-Intro-to-Drinking-Water-Quality-Testing.pdf

The following text was taken from the Introduction to Drinking Water Quality Testing document:

CAWST is a Canadian non-profit organization focused on the principle that clean water changes lives. Safe water and basic sanitation are fundamentals necessary to empower the world's poorest people and break the cycle of poverty. CAWST believes that the place to start is to teach people the skills they need to have safe water in their homes. CAWST transfers knowledge and skills to organizations and individuals in developing countries through education, training and consulting services. This ever expanding network can motivate individual households to take action to meet their own water and sanitation needs.

10.3 Groundwater Sampling

10.3.1 - Best Management Practices for Pre-Drilling Water Sampling

Ohio Department of Natural Resources

www.dnr.state.oh.us/

http://www.cala.ca/sampling/52_BMP_PRE-DRILLING_WATER_SAMPLING.pdf

The following text was taken from the Best Management Practices for Pre-Drilling Water Sampling document:

Groundwater Sampling
Oil and gas wells are drilled through shallow freshwater aquifers. In order to protect freshwater from contamination, State permitting geologists carefully review oil and gas company applications for permits to drill. The State permitting geologists place requirements on permits to ensure groundwater aquifer protection. The permit requirements are enforced through the Division of Division of Oil and Gas Resources Management (DOGRM) Regulatory Enforcement Program. State inspectors witness and document drilling operations for environmental safety to protect natural resources, including fresh water.

As an added measure of verification, the State may require oil and gas companies to sample water wells before a crude oil or natural gas well is drilled. Oil and gas companies are required to submit water well sampling data to the Ohio Department of Natural Resources, Division of Oil and Gas Resources Management (DOGRM). DOGRM will maintain the sampling data. The sampling data will serve as background or historic groundwater quality information. Should the need arise, the background information will be used by the DOGRM Technical Section to conduct hydrologic investigations of domestic water supplies. If a private water supply is impacted by oil and gas operations, the DOGRM Technical and Enforcement Sections work with the property owner and the oil and gas company to resolve the problem. This State service is provided without cost to the property owner.

The following sections summarize procedures and protocol to ensure water well samples are collected and tested to provide useful background information. Links to USEPA and OEPA websites are provided for more detailed discussions of each topic.

10.3.2 - Groundwater Sampling and Analysis – A Field Guide

GEOSCIENCE AUSTRALIA
RECORD 2009/27
Baskaran Sundaram, Andrew J. Feitz, Patrice de Caritat, Aleksandra Plazinska,
Ross S. Brodie, Jane Coram and Tim Ransley
ISSN 1448-2177
ISBN 978-1-821672-08-8 (Hardcopy)
ISBN 978-1-921672-07-1 (Web)
GeoCat # 68901

http://www.ga.gov.au/image_cache/GA15501.pdf

The following text was taken from the Groundwater Sampling and Analysis – A Field Guide:

The purpose of this field guide is to present a set of standard groundwater sampling protocols that focus on a range of groundwater quantity and quality issues throughout Australia. A uniform, accurate and reliable set of sampling procedures will foster the collection of comparable data of a known standard. Ultimately, this allows for greater confidence in the interpretation of any field based data. This guide does not cover the aspects of core sampling, geological grain size analysis, pore fluid extraction and analysis.

SCOPE OF THIS GUIDE
This guide has been developed to provide sufficient information to plan and carry out field groundwater sampling of a high standard, ensuring that only representative, high integrity samples are collected and submitted for laboratory analysis. The main aims of the guide are to:

• provide a comprehensive practical overview covering the basic elements of effective groundwater sampling
• provide simple and efficient methods for monitoring groundwater systems, and
• outline procedures for sampling from the bore site to delivery to the laboratory.

10.3.3 - Best Practice Low Flow Methods for Highest Quality Samples

Low Flow Sampling
SOLINST TECHNICAL BULLETIN
High Quality Groundwater and Surface Water Monitoring Instrumentation
Solinst Canada Ltd., 35 Todd Road, Georgetown, ON L7G 4R8
www.solinst.com

http://www.solinst.com/products/groundwater-samplers/407-bladder-pumps/user-tips/low-flow-sampling.php

The following text was taken from the Best Practice Low Flow Methods for Highest Quality Samples:

Since 1996, low flow sampling has become an increasingly approved method for obtaining high quality groundwater samples.

Through the work of Puls and Barcelona, the US EPA released standard operating procedures for low flow sampling (EPA/540/S-95/504). Following such guidelines ensures the collection of samples that are representative of actual in-situ conditions.

Low flow purging and sampling involves extracting groundwater at rates comparable to ambient groundwater flow (typically less than 500 ml/min), so that the drawdown of the water level is minimized, and the mixing of stagnant water with water from the screened intake area in a well is reduced.

Stabilization of parameters (pH, D.O. conductivity, temperature, etc.) and turbidity of the purged water are monitored before a sample is taken, thus low flow methods facilitate equilibrium with the surrounding formation and produce samples that are truly representative of the formation water.

10.3.4 - Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures

Robert W. Puls1 and Michael J. Barcelona2
United States Environmental Protection Agency
Office of Solid Waste and Emergency Response
Office of Research and Development
EPA/540/S-95/504
April 1996

http://www.epa.gov/superfund/remedytech/tsp/download/lwflw2a.pdf

The following text was taken from Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures:

Introduction
The methods and objectives of ground-water sampling to assess water quality have evolved over time. Initially the emphasis was on the assessment of water quality of aquifers as sources of drinking water. Large water-bearing units were identified and sampled in keeping with that objective. These were highly productive aquifers that supplied drinking water via private wells or through public water supply systems.

Gradually, with the increasing awareness of subsurface pollution of these water resources, the understanding of complex hydrogeochemical processes which govern the fate and transport of contaminants in the subsurface increased. This increase in understanding was also due to advances in a number of scientific disciplines and improvements in tools used for site characterization and ground-water sampling. Ground-water quality investigations where pollution was detected initially borrowed ideas, methods, and materials for site characterization from the water supply field and water analysis from public health practices. This included the materials and manner in which monitoring wells were installed and the way in which water was brought to the surface, treated, preserved and analyzed.

The prevailing conceptual ideas included convenient generalizations of ground-water resources in terms of large and relatively homogeneous hydrologic units. With time it became apparent that conventional water supply generalizations of homogeneity did not adequately represent field data regarding pollution of these subsurface resources. The important role of heterogeneity became increasingly clear not only in geologic terms, but also in terms of complex physical, chemical and biological subsurface processes. With greater appreciation of the role of heterogeneity, it became evident that subsurface pollution was ubiquitous and

encompassed the unsaturated zone to the deep subsurface and included unconsolidated sediments, fractured rock, and aquitards or low-yielding or impermeable formations. Small-scale processes and heterogeneities were shown to be important in identifying contaminant distributions and in controlling water and contaminant flow paths.

10.3.5 – Ground Water Forum

United States Environmental Protection Agency

http://www.epa.gov/superfund/remedytech/tsp/gwforum.htm

The following text was taken from Ground Water Forum:

The Ground Water Forum is a group of ground-water scientists that support the Superfund and RCRA programs in each of the ten EPA Regional Offices. The group was organized to exchange up-to-date information related to ground-water remediation issues at Superfund and RCRA sites. Additional participants come from the EPA Laboratory System and EPA Headquarters. The Forum promotes communication between the Regions and the Laboratories and has three primary purposes. First, to bring the current state-of-the-science to each regional office as it is developed through the research efforts at the labs. Second, to focus laboratory resources on research areas important to the ground-water scientists working in each EPA Region. Finally, the Forum works to maintain consistency in the interpretation of guidance and application of policy throughout the country.

10.3.6 – Ground Water Sample Preservation at In-Situ Chemical Oxidation Sites – Recommended Guidelines

Saebom Ko[1], Scott G. Huling[2], Bruce Pivetz[3]

1 National Research Council, Robert S. Kerr Environmental Research Center, P.O. Box 1198, Ada, OK, 74820;
2,(Corresponding Author) U.S. Environmental Protection Agency, National Risk Management Research Laboratory, Robert S. Kerr Environmental Research Center, P.O. Box 1198, Ada OK, 74820;
3 Shaw Environmental & Infrastructure, Inc., Robert S. Kerr Environmental Research Center, P.O. Box 1198, Ada, OK, 74820

http://www.epa.gov/superfund/remedytech/tsp/download/isco_gw_sampling_issue_paper.pdf

The following text was taken from the Ground Water Sample Preservation at In-Situ Chemical Oxidation Sites – Recommended Guidelines document:

1. INTRODUCTION

In-situ chemical oxidation (ISCO) involves the introduction of a chemical oxidant into the subsurface for the purpose of transforming ground water and/or soil contaminants into less harmful chemical by-products (Huling and Pivetz, 2006; Rivas, 2006; Ferrarese et al., 2008; Kao et al., 2008). Often, ground water samples collected specifically to analyze organic contaminants may contain the oxidant and the organic contaminants in a "binary mixture" (Huling et al., 2011a; Johnson et al., 2012). When organic contaminants and oxidants are commingled in the ground water sample, there is significant potential for oxidative transformation of contaminants to occur after the sample is collected and the results of the sample analysis to become non-representative of in-situ conditions at the time of sampling. Consequently, the quality of the ground water sample may be compromised and a false negative result may occur.

An integral component of ISCO is the collection and analysis of ground water samples to assess ISCO treatment performance. A technical issue faced by Remedial Project Managers is the collection and analysis of representative, high quality ground water samples that can be used to support a site assessment and remedial performance monitoring at sites where ISCO is being deployed. The purpose of this Issue Paper is to provide background information and general guidelines involving methods and procedures that can be used to detect whether an oxidant (i.e., permanganate or persulfate) is present in ground water, to approximate the oxidant concentration, and to estimate and deliver the volume or mass of preservative, specifically ascorbic acid, required to preserve the binary mixture ground water sample. The focus of this Issue Paper is on permanganate and persulfate, two oxidants that can persist for long periods of time in the subsurface and therefore represent the greatest potential for binary mixture ground water samples. An Appendix to this Issue Paper (Recommended Operating Procedures - Preservation of Ground Water Samples at ISCO Sites Using Ascorbic Acid) provides specific details regarding the preservation procedures for use by EPA Regional personnel, contractors, and other environmental professionals engaged in ground water sample collection and analysis.

10.4 Soil Sampling

10.4.1 - Soil Gas Sampling

SOP#: 2042
DATE: 06/01/96
REV. #: 0.0
US Environmental Protection Agency
Environmental Response Team

http://www.cala.ca/sampling/38_soil_gas_sampling.pdf

The following text was taken from the Soil Gas Sampling document:

SCOPE AND APPLICATION
Soil gas monitoring provides a quick means of waste site evaluation. Using this method, underground contamination can be identified, and the source, extent, and movement of the pollutants can be traced. This standard operating procedure (SOP) outlines the

methods used by U.S. EPA/ERT in installing soil gas wells; measuring organic vapor levels in the soil gas using a Photoionization Detector (PID), Flame Ionization Detector (FID) and/or other air monitoring devices; and sampling the soil gas using Tedlar bags, Tenax sorbent tubes, and/or Summa canisters.

These are standard (i.e., typically applicable) operating procedures which may be varied or changed as required, dependent on site conditions, equipment limitations or limitations imposed by the procedure.

In all instances, the ultimate procedures employed should be documented and associated with the final report.

10.4.2 - Soil Sampling For Environmental Contaminants, International Atomic Energy Association (IAEA), Vienna, 2004

IAEA-TECDOC-1415
ISBN 92–0–111504–0
ISSN 1011–4289

Printed by the IAEA in Austria
October 2004

http://www.cala.ca/sampling/39_soil_sampling_environmental.pdf

The following text was taken from the Soil Sampling For Environmental Contaminants document:

INTRODUCTION
In recent years, the IAEA has helped many institutions in developing Member States to set up nuclear analytical laboratories through assistance via technical co-operation and co-ordinated research projects, expert services, and fellowship awards. Some of these laboratories have now matured to approach close to self sustainability by providing service analysis for customers in many fields, including geological prospecting and environmental contamination survey.

Quality control and quality assurance concepts have been developed to assist the laboratory personnel to achieve a higher degree of transparency of procedures, minimize potential sources of error, standardize the handling of samples, instruments and data, and in the end, decrease the rate of non-conformance results.

Quality of analytical data is not only expressed by the closeness of a result to a fictive “true value” but also in a realistic estimate of the uncertainty of the results and a comprehensive documentation on how the results were obtained. It is still not common knowledge that any analytical result is associated with a specific uncertainty due to the sample matrix heterogeneity, method performance fluctuation, uncertainty of values assigned to the standards, and so on. The combined uncertainty of these factors can be estimated by repetitive analysis of independent aliquots and has to be shown together with the result.

Soil sampling and sample preparation, which have a crucial influence on the result, should be carefully documented to allow re-evaluation of results if doubts about their reliability come up. In particular, soil sampling for environmental contaminants investigation have been developed in many analytical laboratories

to establish standards and quality control procedures, in order to avoid confusion relating to this very important subject.

The ultimate targets for all kinds of contaminants dispersed within the natural environment through human activities are sediment and soil. Topsoil is a particularly difficult matrix for environmental pollution studies as it is generally composed of a multitude of geological and biological materials resulting from weathering and degradation including particles of different sizes with varying surface and chemical properties. There are so many different soil types categorized according to their content of biological matter, from sandy soils to loam and peat soils, which make analytical characterization even more complicated.

10.4.3 - Soil Sampling

Bulletin 704 (revised)
R. L. Mahler and T. A. Tindall
College of Agriculture
Cooperative Extension System,
University of Idaho, Moscow, Idaho 83844

http://www.cala.ca/sampling/62_Soil_Sampling.pdf

The following text was taken from Soil Sampling Bulletin 704:

Environmental concerns have brought nutrient management in agriculture under increased scrutiny. A goal of sound nutrient management is to maximize the proportion of applied nutrients that is used by the crop (nutrient use efficiency). Soil sampling is a best management practice (BMP) for fertilizer management that will help improve nutrient use efficiency and protect the environment.

Soil sampling is also one of the most important steps in a sound crop fertilization program. Poor soil sampling procedures account for more than 90 percent of all errors in fertilizer recommendations based on soil tests. Soil test results are only as good as the soil sample. Once you take a good sample, you must also handle it properly for it to remain a good sample.

A good soil testing program can be divided into four operations: (1) taking the sample, (2) analyzing the sample, (3) interpreting the sample analyses, and (4) making the fertilizer recommendations. This publication focuses on the first step, collecting the
soil sample. Once you take a sample, you must send it to a laboratory for analysis.
Then the Extension agricultural educator or fertilizer fieldman in your county can interpret the analysis and make specific fertilizer recommendations.

Fertilizer guides from the University of Idaho Cooperative Extension System are also available to help you select the correct fertilizer application rate.

10.4.4 - Guidance Document for the Implementation of United States Environmental Protection Agency Method 5035: Methodologies for Collection, Preservation, Storage, and Preparation of Soils To Be Analyzed for Volatile Organic Compounds

Department of Toxic Substances Control
California Environmental Protection Agency
November 2004

http://www.cala.ca/sampling/17_EPA_method_5035_guidance_document.pdf

The following text was taken from the Guidance Document for the Implementation of United States Environmental Protection Agency Method 5035:

1.0 INTRODUCTION
The United States Environmental Protection Agency (USEPA) Office of Solid Waste promulgated Method 5035, Closed-System Purge-and-Trap Extraction for Volatile Organics in Soil and Waste Samples in June 1997 in SW-846, Test Methods for Evaluating Solid Waste, Physical / Chemical Methods, Update III (Method 5035). More recently, in July 2002, USEPA updated the Method within SW-846 as Method 5035A1.

Method 5035 describes procedures and protocols for the collection of three types of solid samples contaminated with volatile organic compounds (VOCs):

- low-concentration solids (i.e., soil, sludge and sediment),
- high-concentration solids, and
- solid samples with oily waste.

For low-concentration samples, Method 5035 describes a “closed-system purge-and-trap” process to minimize the loss of VOCs due to sample collection and handling. For high-concentration samples, Method 5035 describes procedures for the collection and preservation of samples, but references Method 5030 (Revision 2, December 1996) for the actual analysis of the prepared sample extracts.

The procedures in Method 5035 should be used for the collection of soil samples at all sites in California contaminated with VOCs in order to comply with USEPA Region IX’s Interim Policy and the California Code of Regulations.

The objective of the Interim Policy is to minimize VOC loss from volatilization and biodegradation during sample collection and handling. By minimizing soil sample transfer steps from sampling to analysis, VOC loss due to atmospheric volatilization is reduced. The use of chemical preservatives further minimizes microbial action, yielding soil samples that are more representative of site conditions. Likewise, the protocols of SW-846 are referenced within the California Code of Regulations as a mechanism to achieve.

This Guidance Document does not address all aspects of VOC soil sampling and analysis. The focus of this Guidance Document is the field procedures associated with soil sample collection, storage, preservation, and preparation for VOC analysis, since most VOC loss during soil sampling occurs before the samples arrive at the laboratory. It is not the intent of this Guidance Document to provide specific instructions to stationary

and mobile laboratories on how to perform the analysis of VOCs in soil samples, but rather to provide guidance on the collection of soil samples in the field.

10.4.5 - Manual on methods and criteria for harmonized sampling, assessment, monitoring and analysis of the effects of air pollution on forests, Part IIIa - Sampling and Analysis of Soil, Part IIIb - Soil Solution Collection and Analysis

UNITED NATIONS ECONOMIC COMMISSION FOR EUROPE
CONVENTION ON LONG-RANGE TRANSBOUNDARY AIR POLLUTION
International Co-operative Programme on Assessment and Monitoring of Air Pollution Effects on Forests

http://www.cala.ca/sampling/20_manual-soil-sampling-analysis.pdf

The following text was taken from the Manual on methods and criteria for harmonized sampling:

Introduction
The present part of the manual outlines the sampling, analysis and reporting procedures for a set of soil parameters.

The purpose of the large-scale representative soil survey (Level I) is first of all the assessment of basic information on the chemical soil status and its changes over time, and secondly the assessment of soil properties which determine the forest soil's sensitivity to air pollution. Besides providing soil data for the study of atmospheric deposition effects at the broader scale, the soil survey will serve other purposes, as studies related to climate change (e.g. inventory of carbon storage) and sustainable forest management (e.g. in addition to acidification status, also nitrogen studies and nutrient imbalances).

The intensive soil studies are conducted in selected areas on permanent plots (Level II) where other measurements for the analysis of the forest ecosystem are concentrated. The objectives of the special forest ecosystem analysis are the verification of hypotheses and in-depth analyses of damage mechanisms and the derivation of fundamental knowledge of forecasting future developments.

A third major objective of the large-scale representative soil survey (Level I) is to allow the evaluation of the (quality of) forest soils on a European scale. For the sake of data comparability between countries, a prime prerequisite is that the same methods for soil sampling and analysis are used throughout the network. As such, analytical results obtained by national methods, different from those described in this manual, cannot directly be compared with analytical results obtained by the international reference methods in this manual. Notwithstanding, the participating countries are encouraged to make efforts (where necessary and possible) to allow the comparison of the data obtained in the first survey with those of future surveys.

10.4.6 - Region XIII Superfund Program Residential Soil Lead Sampling Guidance Document

US Environmental Protection Agency
Region 8
999 18th Street, Suite 500
Denver, CO, 80202 – 2466
Final Draft

April 2000

http://www2.epa.gov/sites/production/files/documents/r8_soilpbsampling.pdf

The following text was taken from the Region VIII Superfund document:

Introduction
This document was prepared to assist all US Environmental Protection Agency personnel, State personnel, and contractor / subcontractor personnel who conduct Superfund related residential soil lead sampling for or on behalf of EPA Region VIII. This document presents guidelines for collecting surface and subsurface soil samples.

10.4.7 - Preparation of Soil Sampling Protocols, Sampling Techniques and Strategies

Benjamin J. Mason, Ph.D.
Environmental Research Center
University of Nevada-Las Vegas
Las Vegas, Nevada 89154
ENVIRONMENTAL MONITORING SYSTEMS LABORATORY
OFFICE OF RESEARCH AND DEVELOPMENT
U.S. ENVIRONMENTAL PROTECTION AGENCY
LAS VEGAS, NEVADA 89193

http://www.cala.ca/sampling/57_EPA_Soil_Sampling_Protocols.pdf

The following text was taken from the Preparation of Soil Sampling Protocols document:

BACKGROUND OF REPORT
This report is a guide for assisting Remedial Project Managers (RPM's) and others involved with site assessments and remediation in the development of soil sampling protocols. The document updates a guide published in 1983 (Mason, 1983). Since that time considerable work has been done in the areas of geostatistics, quality assurance, particulate sampling theory, field analysis, and sample handling.

At the time of the 1983 protocol document, volatile organic chemicals (VOC's) were difficult to sample in the soil environment due to the loss of the chemical during sampling and analysis. That situation still exists and is being addressed in a major research effort conducted by the EMSL-LV. Progress is being made, but an acceptable sampling technology has not been recommended by the agency.

Soil gas sampling methods are being used to aid in identifying the location of plumes generated by volatile pollutants. Field gas chromatographs are also available and are being used to provide rapid, inexpensive data for refining sampling and remedial strategies. These field analytical procedures are most appropriate in the exploratory stage and in the cleanup of sites.

The U.S. EPA has developed the use of data quality objectives (DQO's) as a guiding policy for all environmental sampling (U. S. EPA, 1986, 1987a, 1987b). The DQO process is intended to provide the

decision maker with data that meet a predetermined level of precision, accuracy, representativeness, completeness, and comparability.

In addition to identifying the above data characteristics, the DQO's should also specify the detection level needed, the probabilities of false positive (Type I) and false negative (Type II) errors allowable, and the minimum detectable relative difference between data sets that will be required. This later item becomes important when pollutant levels approach a regulatory threshold. Barth et al. (1989) have addressed the quality assurance aspects of soil sampling in a companion document.

Until quite recently, QA/QC efforts within the Agency have been directed primarily at the quality of the laboratory results generated. Field audits (U.S. EPA, 1985) have been done on occasion when requested by RPM's. The National Acidic Precipitation Assessment Program (NAPAP) has developed a system of field audit samples that, when properly utilized, provides an independent assessment of the sources of variation found in the sampling process. Van Ee et al. (1990) has expanded on the guidance developed for the NAPAP and recommends a series of samples interjected into the sample chain that will provide information on the components of variance encapsulated within the data generated by a sampling effort.

Proper application of a components of variance procedure such as a nested sampling scheme (Barth et al., 1989) can greatly aid in determining the sources of variation seen in the results obtained by a sampling program. In order to carry out the components of variance test it is necessary to identify the factors in the sampling process that are introducing the variation in the data. Pitard (1989a, 1989b) identifies seven sources of sampling error and makes suggestions for controlling or estimating the size of these errors. These errors can be used as a guide in selecting the components of variance to be determined by a sampling effort.

Laboratory methodology has reached a point where analytical error contributes only a very small portion of the total variance seen in the data. Examination of the results of a components of variance analysis performed on soils data from an NPL site sampled for
PCBs (Barth et al., 1989) indicated that 92% of the total variation came from the location of the sample, while only 8% was introduced after the sample was taken. Less than 1% of the total could be attributed to the analytical process itself. This points out the need for a reallocation of sampling resources -- money, lab capacity, and personnel. Discussion in later chapters shows how such a reallocation can be made in order to make the most economical use of the samples. Van Ee et al. (1990) also makes suggestions for such a reallocation.

10.4.8 - Surface Soil Sampling, SOP #SRC-OGDEN-02

Technical Standard Operating Procedures SOP No.: SCR-OGDEN-02
Syracuse Research Corporation, ESC - DVO Revision No.: 0
June 14, 2001

http://www.cala.ca/sampling/58_EPA_Surface_Soil_Sampling.pdf

The following text was taken from Surface Soil Sampling, SOP #SRC-OGDEN-02:

PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to provide a standardized method for surface soil sampling, to be used by employees of USEPA Region 8, or contractors and subcontractors supporting USEPA Region 8 projects and tasks. This SOP describes the equipment and operations used for sampling surface soils in areas which will produce data that can be used to support risk evaluations.

Deviations from the procedures outlined in this document must be approved by the USEPA Region 8 Remedial Project Manager, Regional Toxicologist or On-Scene Coordinator prior to initiation of the sampling activity.

RESPONSIBILITIES
The Field Project Leader (FPL) may be an USEPA employee or contractor who is responsible for overseeing the soil sampling activities. The FPL is also responsible for checking all work performed and verifying that the work satisfies the specific tasks outlined by this SOP and the Project Plan. It is the responsibility of the FPL to communicate with the Field Personnel regarding specific collection objectives and anticipated situations that require any deviation from the Project Plan. It is also the responsibility of the FPL to communicate the need for any deviations from the Project Plan with the appropriate USEPA Region 8 personnel (Remedial Project Manager, Regional Toxicologist or On-Scene Coordinator).

Field personnel performing surface soil sampling are responsible for adhering to the applicable tasks outlined in this procedure while collecting samples. The field personnel should have limited discretion with regard to collection procedures, but should exercise judgment regarding the exact location of sample collection, within the boundaries outlined by the FPL.

10.4.9 - The GUCSO - Guidance on Sampling and Analytical Methods for Use at Contaminated Sites in Ontario

Ontario Ministry of Environment and Energy Standards Development Branch
December, 1996
Version 1.1
ISBN-0-7778-4056-1

http://www.ene.gov.on.ca/stdprodconsume/groups/lr/@ene/@resources/documents/resource/std01_079678.pdf

The following text was taken from the Guidance on Sampling and Analytical Methods for Use at Contaminated Sites in Ontario:

Preface
This document provides guidance on a wide range of topics related to site assessment, sampling and analytical methods for use in site clean-ups in Ontario. It is not intended that users of the document read it from cover to cover, but that it help them in their field of interest. Therefore, laboratory personnel will have a greater interest in Section 8 on laboratory methods, whereas field samplers will have a greater interest in the specific media in which they are working. All users should be aware, however, of the interactions between the different activities of site assessment, and they should not work independently. The sections pertaining to project and field Quality Assurance and Quality Control are, for example, pertinent to nearly all users of this document.

10.4.10 - A Guide to Soil Sampling

This is a good document but it is not obvious who produced it.

http://www.cala.ca/sampling/60_Mod2pt1_Soil_Sampling.pdf

The following text was taken from the Guide to Soil Sampling:

This module is a guide to best practice in soil sampling for the measurement of soil water and analysis of nutrients. It contains information on the equipment needed, strategies and methods of sampling, and practical tips for speedy and efficient sampling.

Why Sample Soils
Taking and analysing samples increases our knowledge of the state of the soil.

This can make a farmer make better and more profitable decisions in the management of a crop.

10.4.11 - 2012 Sampling and Analysis Protocol for Ontario Regulation 267/03 Made under the Nutrient Management Act, 2002

Ontario Ministry of Agriculture and Food

http://www.omafra.gov.on.ca/english/nm/regs/sampro/sampro02-12.htm

The following text was taken from the 2012 Sampling and Analysis Protocol for Ontario Regulation 267/03:

Part 2 - Sampling Methods

2.1 Soils In-Situ

2.1.1 Collection of Soil Samples

The goal in collecting soil samples is to provide a small volume of soil for analysis that is representative of the whole volume of soil within the area of interest. There are a number of different ways to accomplish this goal. This section describes the minimum sampling requirements for information purposes and outlines some of the more detailed techniques.

To be representative of the area of interest, the sample is comprised of a number of sub-samples. The sub-samples must include the depth of soil that would normally be tilled. For most nutrients and other regulated parameters this depth is approximately 15 centimeters (6 inches). This depth is appropriate even where no tillage is used, as it represents the part of the soil where most roots are present and most nutrient absorption occurs. The exception to this are the soil nitrate samples, which are collected at a depth of 30 cm (12 inches) to include nitrate which may have been leached from the surface soil to the lower part of the rooting zone. To collect sub-samples at the proper depth, the easiest equipment to use is a sampling tube or auger, which is simply inserted to the proper depth and then removed, bringing the sample with it. A shovel or spade can be used instead, but it is more labour intensive than a sampling tube or auger, and it is much more difficult to keep each sub-sample of uniform size.

The pattern of sub-sample collection must provide a representative sample of the entire area. It means: 1) sufficient sub-samples (e.g. cores) must be collected, 2) the sub-samples must be collected so as not to introduce bias into the representative sample, 3) the area being sampled must be reasonably uniform, and 4) the area being sampled must not be too large.

10.5 Sediment Sampling

10.5.1 - Sediment Sampling, 1.0 Scope and Application

This standard operating procedure (SOP) is applicable to the collection of representative sediment samples.
SOP#: 2016
DATE: 11/17/94
REV. #: 0.0
US Environmental Protection Agency
Environmental Response Program

http://www.cala.ca/sampling/55_EPA_Sediment_sampling.pdf

The following text was taken from the Sediment Sampling document:

Analysis of sediment may be biological, chemical, or physical in nature and may be used to determine the following:

- toxicity;
- biological availability and effects of contaminants;
- benthic biota;
- extent and magnitude of contamination;
- contaminant migration pathways and source;
- fate of contaminants;
- grain size distribution.

The methodologies discussed in this SOP are applicable to the sampling of sediment in both flowing and standing water. They are generic in nature and may be modified in whole or part to meet the handling and analytical requirements of the contaminants of concern, as well as the constraints presented by site conditions and equipment limitations.

However, if modifications occur, they should be documented in a site or personal logbook and discussed in reports summarizing field activities and analytical results.

For the purposes of this procedure, sediments are those mineral and organic materials situated beneath an aqueous layer. The aqueous layer may be either static, as in lakes, ponds, and impoundments; or flowing, as in rivers and streams.

10.5.2 - Sediment Sampling SRC-OGDEN-04

Technical Standard Operating Procedure SOP No: SRC-OGDEN-04
Syracuse Research Corporation - ESC, DVO Revision No.: 0
June 14, 2001
Sediment SOP.wpd

http://www2.epa.gov/sites/production/files/documents/r8-src_src-ogden-04.pdf

The following text was taken from Sediment Sampling SRC-OGDEN-04:

PURPOSE
The purpose of this Standard Operating Procedure (SOP) is to provide a standardized method for collecting sediment samples at hazardous waste sites. This SOP may be used by employees of USEPA Region 8, or contractors and subcontractors supporting USEPA Region 8 projects and tasks. Deviations from the procedures outlined in this document must be approved by the USEPA Region 8 Remedial Project Manager, Regional Toxicologist or On-Scene Coordinator prior to initiation of the sampling activity.

This standard operating procedure (SOP) is applicable to the collection of representative sediment samples. Analysis of sediment may be biological, chemical, or physical in nature and may be used to determine the following:
• toxicity
• biological availability and effects of contaminants
• benthic biota
• extent and magnitude of contamination
• contaminant migration pathway and potential source
• fate of contaminants
• grain size distribution

The methodologies discussed in this SOP are applicable to the sampling of sediment in both flowing and standing water. For the purposes of this procedure, sediments are those mineral and organic materials situated beneath an aqueous layer. The water may be static, as in lakes, ponds, and impoundments; or flowing, as in rivers and streams.

10.5.3 - Sediment Sampling SOP #EH-02

(Adapted from ERT/REAC SOP #2016 Rev 0.0)
SOP#EH-02, East Helena Site, Montana
September 2003

http://www2.epa.gov/sites/production/files/documents/r8-src_eh-02.pdf

The following text was taken from Sediment Sampling SOP #EH-02:

1.0 PURPOSE
The purpose of this Standard Operating Procedure (SOP) is to provide a standardized method for collecting sediment samples at hazardous waste sites. This SOP may be used by employees of USEPA Region 8, or

contractors and subcontractors supporting USEPA Region 8 projects and tasks. Deviations from the procedures outlined in this document must be approved by the USEPA Region 8 Remedial Project Manager, Regional Toxicologist or On-Scene Coordinator prior to initiation of the sampling activity.

This standard operating procedure (SOP) is applicable to the collection of representative sediment samples. Analysis of sediment may be biological, chemical, or physical in nature and may be used to determine the following:

• toxicity
• biological availability and effects of contaminants
• benthic biota
• extent and magnitude of contamination
• contaminant migration pathway and potential source
• fate of contaminants
• grain size distribution

The methodologies discussed in this SOP are applicable to the sampling of sediment in both flowing and standing water. They are generic in nature and may be modified in whole or part to meet the handling and analytical requirements of the contaminants of concern, as well as the constraints presented by site conditions and equipment limitations. However, if modifications occur, they should be documented in a site or personal logbook and discussed in reports summarizing field activities and analytical results. For the purposes of this procedure, sediments are those mineral and organic materials situated beneath an aqueous layer. The water may be static, as in lakes, ponds, and impoundments; or flowing, as in rivers and streams.

10.6 Solid Waste Sampling

10.6.1 - Solid Waste, Municipal: Sampling and Characterisation

Published by NORDTEST
Tekniikantie 12,
FIN-02150
ESPOO FINLAND
ISSN 0238-4445
www.nordtest.org

http://www.cala.ca/sampling/23_NT_envir001_Solid_waste_municipal_Sampling_and_characterisation_Nordtest_Method.pdf

The following text was taken from the NORDTEST Solid Waste, Municipal: Sampling and Characterisation document:

SCOPE
The function of this test method is to obtain information about the amount and composition of solid waste, primarily household waste and similar mixed waste from various enterprises and activities, excluding branch-specific waste from industry, agriculture, construction and demolition, energy production and solid and liquid waste treatment plants. As a general rule, all waste containing components which are easily detectable by humans and can be hand-sorted, can be analysed by the test methods described.

The function is nevertheless dependent on the purpose of the investigation and on who or what the investigation is directed at. Therefore, this test description gives advice and rules rather than exact procedures.

The test includes determination of specific waste generation rate (SWG) and the physical component-wise composition of the solid waste, as well as sample preparation for further chemical and physical analysis. The flowsheet below illustrates the elements which are included in the method with reference to the appropriate sections.

10.7 Biological Sampling

10.7.1 - City of Moncton Weekly Bacteriological Sampling – COA Sites

POLICIES, PROCEDURES & SPECIFICATIONS
No.: WS5
Type: Procedure
Name: Weekly Bacteriological Sampling – COA Sites

http://www.cala.ca/sampling/47_WS5_Weekly_Bacteriological_Sampling_Moncton.pdf

The following text was taken from the City of Moncton Weekly Bacteriological Sampling

Role:
The City of Moncton, through its Provincial Certificate to Operate, is responsible to collect water samples within the tri-community service area at locations as stipulated in the approved Sampling Plan. Water supply staff is designated to collect these samples weekly (on Tuesdays) and arrange for transportation to the NBDOE lab in Fredericton for testing. The following is the basic procedure to be followed by staff completing this work.

10.7.2 - Best Practices for Using Microbiological Sampling, Developed by Beef Industry Food Safety Council (BIFSCo), March 2008

http://www.cala.ca/sampling/50_308_Best_Practices_for_Using_Microbiological_Sampling.pdf

The following text was taken from the Best Practices for Using Microbiological Sampling, Developed by Beef Industry Food Safety Council document:

Due to the wide variety of products and processes employed within the beef industry, BIFSCo has limited the scope of this document to include only the sampling and testing during slaughter, fabrication, and the production of raw ground beef.

Scope:

When applied properly, microbiological sampling is a tool that can be used by processing establishments to evaluate process control. If microbiological sampling is not properly used, it can give a false sense of security that the process is in control when it is not. Therefore, this document is designed to provide best practices that can be applied throughout the industry to help develop appropriate procedures for using microbiological testing to verify process control. As with all best practices, each establishment will need to customize the best practices to fit individual operations.

Introduction:
Microbiological testing is not designed to test safety of the product, and end-product testing should not be used to replace verification of process control and validation of microbial interventions. It is important to remember that HACCP was initially developed as a preventive process control system for food safety hazards, because end-product testing was not capable of determining product safety.
Before an establishment develops and implements a microbiological testing program, it should know how the results are going to be used and the impact of the results on the product.

This document will focus on using microbiological testing for:
• process control verification
• trim sampling
• finished product sampling

10.7.3 - AOAC International Presidential Task Force on Best Practices for Microbiological Methodology

Appendix C - Sampling WG Executive Summary 8-8-066
Page 1 of 4
AOAC INTERNATIONAL
Presidential Task Force on
Best Practices for Microbiological Methodology
US FDA Contract #223-01-2464, Modification #12

http://www.cala.ca/sampling/51_AOAC_Sampling_Task_Force.pdf

The following text was taken from the AOAC International Presidential Task Force on Best Practices for Microbiological Methodology document:

Executive Summary
Sampling Working Group (SAWG)

INTRODUCTION
As with any type of testing, an understanding of the sampling and measurement procedures for microbiological methods is necessary for gaining confidence that the obtained results “represent” the intended population or fulfill a study’s purpose. The confidence of results can be undermined if care is not taken to control and minimize the variation of observed results due to sampling, sample preparation and measurement. To address this concern, the AOAC has asked the Sampling Working Group (SAWG) of the BPMM Task Force to identify and address the components of sampling and measurement variation – specifically, the factors that contribute to and must be controlled or understood in order to gain an

understanding of results and thereby enhance their proper use. This would include identifying components across the whole process of sampling and measurement, including the method of measurement and the laboratory performance.
Once these components of variation are understood, proper application of the method can be designed.

There has been significant work done by the International Commission on Microbiological Specifications for Foods (see ICMSF, 2002) to develop and provide guidance on the use of microbiological sampling plans for foods. The statistics underlying these sampling plans, however, are not well understood (Dahms, 2004). The components of variation, referred to above, were not considered in determining the operating characteristics of the plans; instead, rather idealized assumptions were made.

10.7.4 - Public Health Inspector's Guide to the Principles and Practices of Environmental Microbiology. 4th ed.

For more information, see this entry in Section 3 on Legal Sampling

http://www.cala.ca/sampling/28_PHO_PUBLIC_HEALTH_INSPECTORS_GUIDE_2013.pdf

10.7.5 - Salmonella testing of turkey flocks

European Communities (Control of salmonella in turkeys) Regulations 2010 (S.I. No. 99 of 2010).
Irish Department of Agriculture

Turkeysalmonellatestingrequirements191010

http://www.cala.ca/sampling/61_Turkeysalmonellatestingrequirements191010.pdf

The following text was taken from the Salmonella in turkey flocks document:

There are new compulsory requirements in place for Salmonella testing of both breeding and slaughter turkeys. These follow on from those that were introduced in the broiler breeder broiler and table egg flocks. These are part of an EU wide initiative to reduce Salmonella levels in poultry.

What you have to do now -
If you have a flock for slaughter you are required to sample the flock three weeks before the flock moves to slaughter. These results remain valid for six weeks, which means that you may have to sample twice if you move to a slaughterhouse in stages.

If you have a breeding flock you must sample it at day old, four weeks and two weeks before moving to slaughter and every three weeks during the laying period. The sampling methods are included with this note.

Samples should be sent by express mail or courier service within twenty-four hours of collection to any of the approved laboratories that are listed in Annex 1 of this note. You must keep records of sampling on farm for a minimum of three years to include the date the sample was taken, the house number and the laboratory result. If you have more than one house on site then all houses need to be sampled.

Birds cannot be sent for slaughter unless they are accompanied by the test result, which should be entered on the food chain information document, the laboratory test result or by some other suitable means of communication that verifies the Salmonella status of the flock. If the status of your flock is not verified before slaughter it will be treated as a Salmonella positive flock and will be slaughtered and processed accordingly. Records should also be kept on the premises to include date birds moved in and out, house number, and the address from which they came and the address to where they went.

Department inspectors will conduct occasional sampling at your holding and check the records and results of private testing. Please retain these records and results at the farm for this purpose.

10.7.6 - MFLP-41 Environmental Sampling for the Detection of Microorganisms July 2010

Health Canada
Laboratory Procedures for the Microbiological Analysis of Foods

http://www.hc-sc.gc.ca/fn-an/res-rech/analy-meth/microbio/volume3-eng.php

The following text was taken from the MFLP-41 Environmental Sampling for the Detection of Microorganisms:

The Laboratory Procedures for the Microbiological Analysis of Foods are available upon request. Please select the appropriate link in the table below to send your request via email, or contact Health Canada's publication office to make your request.

10.7.7 Microorganisms in Foods 2. Sampling for microbiological analysis: Principles and specific applications. 2nd Ed.

International Commission on Microbiological Specifications for Foods.
US FDA BAM: Food Sampling/Preparation of Sample Homogenate , April 2003, Bacteriological Analytical Manual, Chapter 1, Food Sampling and Preparation of Sample Homogenate Authors: Wallace H. Andrews and Thomas S. Hammack

http://www.icmsf.org/pdf/icmsf2.pdf

The following text was taken from Microorganisms in Foods 2. Sampling for microbiological analysis: Principles and specific applications. 2nd Ed.:

Introduction:
The application and use of criteria

This chapter provides background information on the considerations which have led the Commission to propose microbiological criteria for some commodities and not others. It also indicates how the criteria should be interpreted and applied.

A. FORMAT OF COMMODITY CHAPTERS

In the first edition of this book foods were grouped on the basis of commodities (e.g., milk and milk products) or processes (e.g., frozen foods, dried foods). In this edition the commodities grouping used in Microbial Ecology of Foods, vol. 2 (ICMSF 1980), has been followed with two exceptions. These are formulated foods, comprising raw materials from several commodity groups, and low-acid canned products. Criteria for formulated foods will depend on conditions of manufacture, the types of raw materials used, the process, the intended distribution system, and shelf-life. Hence criteria are proposed only where a need has been demonstrated and such information is available (see Chapter 24, Formulated Foods). Sampling plans and microbiological tests are not relevant to the safety of shelf-stable canned foods and are therefore not proposed. Extensive cross-reference is made to the volume referred to above (ICMSF 1980) so that information pertaining to the need for criteria and the appropriate cases may readily be found.

Each chapter discusses the microbiological hazards associated with a commodity group and, based on a consideration of their relevance, may propose criteria. General sampling procedures are dealt with in Chapter 9, but if a commodity requires special sampling procedures Reprinted from: Microorganisms in Foods 2. Sampling for microbiological analysis: Principles and specific applications. 2nd Ed. International Commission on Microbiological Specifications for Foods. 128 Proposals for sampling and sample plans these are detailed within the chapter. For methods, reference is made to ICMSF, 1978, or to other appropriate sources.

10.8 Sampling Food

10.8.1 - US FDA BAM: Food Sampling/Preparation of Sample Homogenate April 2003, Bacteriological Analytical Manual

Chapter 1
Food Sampling and Preparation of Sample Homogenate
Authors: Wallace H. Andrews and Thomas S. Hammack

Revision History: April 2003 Revised section A.1.a, Salmonella species sample collection.

http://www.fda.gov/Food/FoodScienceResearch/LaboratoryMethods/ucm063335.htm

The following text was taken from the Food Sampling and Preparation of Sample Homogenate website:

The adequacy and condition of the sample or specimen received for examination are of primary importance. If samples are improperly collected and mishandled or are not representative of the sampled lot, the laboratory results will be meaningless. Because interpretations about a large consignment of food are based on a relatively small sample of the lot, established sampling procedures must be applied uniformly. A representative sample is essential when pathogens or toxins are sparsely distributed within the food or when disposal of a food shipment depends on the demonstrated bacterial content in relation to a legal standard.

The number of units that comprise a representative sample from a designated lot of a food product must be statistically significant. The composition and nature of each lot affects the homogeneity and uniformity of the total sample mass. The proper statistical sampling procedure, according to whether the food is solid, semisolid, viscous, or liquid, must be determined by the collector at the time of sampling by using the Investigations Operation Manual (5). Sampling and sample plans are discussed in detail in ref. 6.

Whenever possible, submit samples to the laboratory in the original unopened containers. If products are in bulk or in containers too large for submission to the laboratory, transfer representative portions to sterile containers under aseptic conditions. There can be no compromise in the use of sterile sampling equipment and the use of aseptic technique. Sterilize one-piece stainless steel spoons, forceps, spatulas, and scissors in an autoclave or dry-heat oven. Use of a propane torch or dipping the instrument in alcohol and igniting is dangerous and may be inadequate for sterilizing equipment.

Use containers that are clean, dry, leak-proof, wide-mouthed, sterile, and of a size suitable for samples of the product. Containers such as plastic jars or metal cans that are leak-proof may be hermetically sealed. Whenever possible, avoid glass containers, which may break and contaminate the food product. For dry materials, use sterile metal boxes, cans, bags, or packets with suitable closures. Sterile plastic bags (for dry, unfrozen materials only) or plastic bottles are useful containers for line samples. Take care not to overfill bags or permit puncture by wire closure. Identify each sample unit (defined later) with a properly marked strip of masking tape. Do not use a felt pen on plastic because the ink might penetrate the container. Whenever possible, obtain at least 100 g for each sample unit. Submit open and closed controls of sterile containers with the sample.

Deliver samples to the laboratory promptly with the original storage conditions maintained as nearly as possible. When collecting liquid samples, take an additional sample as a temperature control. Check the temperature of the control sample at the time of collection and on receipt at the laboratory. Make a record for all samples of the times and dates of collection and of arrival at the laboratory. Dry or canned foods that are not perishable and are collected at ambient temperatures need not be refrigerated. Transport frozen or refrigerated products in approved insulated containers of rigid construction so that they will arrive at the laboratory unchanged. Collect frozen samples in pre-chilled containers.

Place containers in a freezer long enough to chill them thoroughly. Keep frozen samples solidly frozen at all times. Cool refrigerated samples, except shellfish and shell stock, in ice at 0-4°C and transport them in a sample chest with suitable refrigerant capable of maintaining the sample at 0-4°C until arrival at the laboratory. Do not freeze refrigerated products. Unless otherwise specified, refrigerated samples should not be analyzed more than 36 h after collection. Special conditions apply to the collection and storage of shucked, unfrozen shellfish and shell stock (1). Pack samples of shucked shellfish immediately in crushed ice (no temperature specified) until analyzed; keep shell stock above freezing but below 10C. Examine refrigerated shellfish and shell stock within 6 h of collection but in no case more than 24 h after collection. Further details on sample handling and shipment may be found in the Investigations Operation Manual (5) and the Laboratory Procedures Manual (3). The Investigations Operation Manual (5) contains sampling plans for various microorganisms. Some of those commonly used are presented here.

10.8.2 - Measurement uncertainty arising from sampling: A guide to methods and approaches (2007):

See Section 5.7 for this document which contains case studies on the sampling of food and animal feed, and how to estimate the uncertainty it generates in measurements.

10.9 Tank and Vessel Sampling

10.9.1 - UST Section - Guidelines for Sampling

STATE of NORTH CAROLINA
DEPARTMENT of ENVIRONMENT and NATURAL RESOURCES
DIVISION of WASTE MANAGEMENT
UNDERGROUND STORAGE TANK SECTION
Version 1.2 September 1, 2003

http://www.cala.ca/sampling/44_UST_sampling_guidelines_2003.pdf

The following text was taken from the UST Section - Guidelines for Sampling:

Purpose and Application of the Guidelines
The purpose of this document is to provide guidance on the sampling process for environmental monitoring associated with underground storage tank systems. Questions concerning the information presented in this document should be directed to the UST Section Central Office at 919-733-8486. Questions concerning a specific site should be directed to the UST Section Regional Office that is responsible for the county in which the site is located.

General Sampling Procedures
Sampling activities are associated with UST closures, soil remediation permitting and assessment and corrective actions. A systematic sampling approach must be used to assure that sample collection activities provide usable data. Sampling must begin with an evaluation of background information, historical data and site conditions. General sampling procedures are described in this section. The location, type and number of environmental samples for specific monitoring activities (e.g. closure, ex-situ soil remediation and assessment and corrective action) are described in the specific guideline documents for each type of activity. These documents are available in hard copy from the UST Section Central Office and/or Regional Offices, (see Figure 1 for office locations). Electronic versions are available for download from the Division of Waste Management web site at http://wastenot.enr.state.nc.us/. Activity and matrix specific sampling procedures are included in the appendices of this document.

10.10 Sampling of Petroleum Products

10.10.1 - Standard Practice for Manual Sampling of Petroleum and Petroleum Products

ASTM D4057 - 12

http://www.astm.org/Standards/D4057.htm

The following text was taken from the Standard Practice for Manual Sampling of Petroleum and Petroleum Products:

Significance and Use

4.1 Samples of petroleum and petroleum products are obtained for many reasons, including the determination of chemical and physical properties. These properties may be used for: calculating standard volumes; establishing product value; and often safety and regulatory reporting.

4.2 There are inherent limitations when performing any type of sampling, any one of which may affect the representative nature of the sample. As examples, a spot sample provides a sample from only one particular point in the tank, vessel compartment, or pipeline. In the case of running or all-level samples, the sample only represents the column of material from which it was taken.

4.3 Based on the product, and testing to be performed, this practice provides guidance on sampling equipment, container preparation, and manual sampling procedures for petroleum and petroleum products of a liquid, semi-liquid, or solid state, from the storage tanks, flowlines, pipelines, marine vessels, process vessels, drums, cans, tubes, bags, kettles, and open discharge streams into the primary sample container.

1. Scope
1.1 This practice covers procedures and equipment for manually obtaining samples of liquid petroleum and petroleum products, crude oils, and intermediate products from the sample point into the primary container are described. Procedures are also included for the sampling of free water and other heavy components associated with petroleum and petroleum products.

1.2 This practice also addresses the sampling of semi-liquid or solid-state petroleum products.

1.3 This practice provides additional specific information about sample container selection, preparation, and sample handling.

10.11 Air and Air Emissions Sampling

10.11.1 - Operations Manual for Air Quality Monitoring in Ontario

March 2008
Ministry of the Environment
Operations Division
Technical Support Section
PIBS 6687e

http://www.ene.gov.on.ca/stdprodconsume/groups/lr/@ene/@resources/documents/resource/std01_079184.pdf

The following text was taken from the Operations Manual for Air Quality Monitoring in Ontario:

Overview
This Operations Manual for Air Quality Monitoring in Ontario is an update of the 2003 version (Operations Manual for Point Source Air Quality Monitoring) developed by the Ontario Ministry of the Environment (ministry). The manual was originally developed as the ministry transferred the responsibility for monitoring the impact of industrial air emissions on local air quality from the ministry to emitters. This manual is to be used when the need for air quality monitoring by an emitter has been identified. The ministry continues to provide oversight of air quality monitoring conducted by emitters by adopting the role of auditor.

This newly revised Operations Manual, hereafter referred to as the Manual, captures the lessons learned during the first years of the program. The Manual has also been updated to recognize monitoring that may be conducted under Ontario Regulation 419/05: Air Pollution – Local Air Quality with respect to current, new or updated air standards and guidelines.

The Manual also introduces standard operating procedures (SOPs) for new air monitoring and sampling technologies used by emitters. The purpose of the Manual is to provide technical guidance and direction to emitters and station operators in Ontario who are responsible for the operation and maintenance of air quality monitoring stations near an emitter's facilities. It provides a framework with the goal of harmonizing air contaminant monitoring across the province. The intent of the Manual is to ensure the collection of reliable and accurate air quality data, and to ensure that the data is collected and reported to the ministry in a timely fashion, as appropriate.

The Manual includes the following topics:
• Quality Assurance/Quality Control (QA/QC) Guidance
• Requirements for reporting monitoring and sampling results to the ministry
• Station and Probe Siting Criteria
• Standard Operating Procedures (SOPs) for continuous monitoring and noncontinuous sampling methods

10.11.2 - Ambient Air Monitoring Protocol for PM2.5 and Ozone

PN 1456
ISBN 978-1-896997-99-5 PDF

Canadian Council of Ministers of the Environment
123 Main St., Suite 360
Winnipeg, Manitoba R3C 1A3
www.ccme.ca

http://www.ccme.ca/assets/pdf/pm_oz_cws_monitoring_protocol_pn1456_e.pdf

The following text was taken from the Ambient Air Monitoring Protocol for PM2.5 and Ozone:

EXECUTIVE SUMMARY
(Monitoring Protocol) should be read in the context of at least two other documents: the Guidance Document on Achievement Determination (GDAD), and the Guidance Document on Keeping Clean Areas Clean and Continuous Improvement (CCME 2007a and b).

The primary purpose of the Monitoring Protocol is to ensure comparability of data across the various ambient monitoring networks in Canada (refer to Section 3) that will be used to achieve the following objectives for the CWS:
• measure representative PM and ozone concentrations in populated areas across the country;
• measure the highest representative ozone concentrations in metropolitan areas;
• measure background concentrations and transport of PM and ozone into areas impacted by transboundary levels;

• support the development of appropriate management strategies on a regional basis;
• track and report attainment progress;
• ensure measurements are reliable and inter-comparative across all regions.

The Monitoring Protocol presents guidelines that will serve as a minimum requirement for networks collecting ambient data in support of the CWS. Adoption of common standards across the country ensures that data collected by networks in different jurisdictions can be analyzed as a consistent dataset, thus increasing the power of statistical methods and gaining maximum scientific return from resources invested. The adoption of national data quality objectives (DQOs) also allows individual networks to exceed those standards where technology and resources permit.

In this document, DQOs are defined as "measurable attributes of the monitoring data that will allow program objectives and measurement objectives to be met." These performance-based objectives have been defined to allow new and emerging technologies to be incorporated into monitoring activities as they are shown to meet network DQOs.

10.12 Sampling Biosolids

10.12.1 - Nutrient Management Act, 2002, ONTARIO REGULATION 267/03

http://www.e-laws.gov.on.ca/html/regs/english/elaws_regs_030267_e.htm

The following text was taken from the Nutrient Management Act, 2002:

Manure and Anaerobic Digestion Output

Sampling obligations

91. (1) Each person who is required to have a nutrient management plan for an agricultural operation, in the course of which manure or anaerobic digestion output that falls within the definition of agricultural source material is applied to land, that is the first such plan for the operation, shall, as part of preparing the plan,

(a) collect at least one sample from the soil of the land or, if the plan deals with land in parts under subsection 24 (3), from each part of the land and have the sample analyzed in accordance with subsection (4) to determine the concentration of each of the following parameters: plant available phosphorus, plant available potassium; or

(b) for the purpose of subsection 92 (1), use the following concentrations to calculate the maximum application rate to land:

(i) 101 milligrams per litre of plant available phosphorus in the soil of the land.

(ii) 251 milligrams per litre of plant available potassium in the soil of the land. O. Reg. 511/05, s. 48; O. Reg. 394/07, s. 15 (1); O. Reg. 338/09, s. 68 (1-3).

(2) Each person who is required to have a nutrient management plan for an agricultural operation, in the course of which manure or anaerobic digestion output that falls within the definition of agricultural source material is applied to land, that is not the first such plan for the operation, shall, as part of preparing the plan, collect at least one sample from the soil of the land or, if the plan deals with land in parts under subsection 24 (3), from each part of the land and have the sample analyzed in accordance with subsection (4) to determine the concentration of each of the following parameters: plant available phosphorus and plant available potassium. O. Reg. 511/05, s. 48; O. Reg. 394/07, s. 15 (2); O. Reg. 338/09, s. 68 (4).

(3) Each person who is required to have a nutrient management plan for an agricultural operation, in the course of which manure or anaerobic digestion output that falls within the definition of agricultural source material is applied to land, shall, as part of preparing the plan,

(a) collect at least one sample of each type of the manure or anaerobic digestion output applied to the land and have the sample analyzed in accordance with subsection (4) to determine the concentration of each of the following parameters: ammonia and ammonium nitrogen, total Kjeldahl nitrogen, total phosphorus, total potassium and total solids; or

(b) obtain the default data from the Nutrient Management Protocol in relation to each parameter listed in clause (a). O. Reg. 511/05, s. 48; O. Reg. 394/07, s. 15 (3, 4); O. Reg. 338/09, s. 68 (5); O. Reg. 284/12, s. 7 (2).

(4) The analysis mentioned in subsection (1) or (2) shall be performed by a laboratory that is accredited by the Ministry of Agriculture, Food and Rural Affairs for that purpose. O. Reg. 394/07, s. 15 (5).

(5) The analysis mentioned in subsection (3) shall be performed by,

(a) a laboratory that is accredited by the Ministry of Agriculture, Food and Rural Affairs for that purpose; or

(b) a laboratory that is accredited in accordance with the International Standard ISO/IEC 17025 — General Requirement for the Competence of Testing and Calibration Laboratories, dated December 15, 1999, as amended from time to time. O. Reg. 394/07, s. 15 (5).

<u>Non-Agricultural Source Materials — Sampling and Analysis</u>

Sampling and analysis procedures

93. (1) Each person who is required under section 94 or 95 to collect a sample shall do so in accordance with this Part and the methods specified in the Sampling and Analysis Protocol. O. Reg. 338/09, s. 70; O. Reg. 284/12, s. 7 (2).

(2) Each person who is required under section 94 or 95 to have a sample analyzed shall have the analysis done in accordance with this Part and the methods specified in the Sampling and Analysis Protocol. O. Reg. 338/09, s. 70; O. Reg. 284/12, s. 7 (2).

(3) Whenever this Part requires a person to collect a sample or to have it analyzed, the sample shall be a composite sample. O. Reg. 338/09, s. 70.

(4) Subsections (1) to (3) apply, with necessary modifications, to testing required by a Director under section 98.0.16. O. Reg. 338/09, s. 70.

Soil testing

94. (1) Each person who is required to have a nutrient management plan or NASM plan for an agricultural operation in the course of which Category 2 or Category 3 NASM is applied to land shall, as part of preparing the plan, collect at least one sample from the soil of the land and have the sample analyzed to determine the concentration of each of the following parameters:

1. Plant available phosphorus.
2. Plant available potassium.
3. Regulated metals.
4. Soil pH. O. Reg. 338/09, s. 70.

10.13 Personal Sampling for Air Contamination

10.13.1 - Sampling, Measurement Methods, and Instruments

OR-OSHA TECHNICAL MANUAL
CHAPTER 1: PERSONAL SAMPLING FOR AIR CONTAMINATION
CHAPTER 2: SAMPLING FOR SURFACE CONTAMINATION
CHAPTER 3: TECHNICAL EQUIPMENT
CHAPTER 4: SAMPLE SHIPPING AND HANDLING

Occupational Safety and Health Administration (OSHA), a federal agency of the United States that regulates workplace safety and health.

http://www.cala.ca/sampling/26_OSHA-sampling-manual.pdf

The following text was taken from the OSHA Sampling, Measurement Methods, and Instruments Manual:

SECTION I: CHAPTER 1
PERSONAL SAMPLING FOR AIR CONTAMINANT
A. INTRODUCTION
Unnecessary air sampling wastes laboratory resources and produces delays in reporting results of necessary sampling. Evaluate the potential for employee overexposure by observing and screening samples before conducting any partial or full-shift air sampling.

Screening with portable monitors, gravimetric sampling, or detector tubes can be used to evaluate the following:

- exposures to substances with exceptionally high permissible exposure limits (PELs) in
- relatively dust-free atmospheres, e.g., ferric oxide and aluminum oxide;
- intermittent processes with substances without short-term exposure limits (STELs);

- engineering controls, work practices, or isolation of process; and the need for CSHO protection.
- substances that have ceiling exposure limits (there are validated direct reading sampling devices available specifically for these substances)

Take a sufficient number of samples to obtain a representative estimate of exposure. Contaminant concentrations vary seasonally, with weather, with production levels, and in a single location or job class.

10.13.2 - Breathing Air Quality, Sampling, and Testing

Environmental Health Laboratory
Department of Environmental and
Occupational Health Sciences
School of Public Health
University of Washington Environmental Health Laboratory

http://www.cala.ca/sampling/53_BreathingAirQualitySamplingTesting.pdf

The following text was taken from the Breathing Air Quality, Sampling, and Testing document:

Overview
In response to queries on alternatives to high-pressure sampling of breathing air and lack of independent information on the accuracy, functionality, durability, and safety of commercially available breathing air quality assessment kits, the Environmental Health Laboratory (EHL) at the University of Washington evaluated six representative breathing air sampling kits. Kits were tested in the laboratory and by personnel at three fire departments and one commercial diving company.

Why is water a problem in collecting a SCBA breathing air sample?
Water is a “sticky” molecule and easily forms an invisible molecular film on surfaces. The absence of visible water does not mean the surface is dry enough to avoid contamination of a dry air sample. Thus, sample containers and fill lines must be thoroughly purged prior to sampling, regardless of appearance.

Water has an affinity for surfaces unless they have been specially treated to make them water-repellent. More water is retained on rougher surfaces. Sample container leaks are another possible source of water contamination. Given that room air contains around 30,000 ppm (3%) water, a small leak will alter a dry air sample with a water concentration of 10–30 ppm. Samples at low pressure are more affected by water contamination problems because at high pressures any water contamination from the container surface is in essence diluted.

10.13.3 - High Volume Indoor Dust Sampling at Residences for Determination of Risk-Based Exposure to Metals

Syracuse Research Corporation
Date: April 1, 2004 (Rev. # 0) SOP No. SRC-DUST-01

http://www2.epa.gov/sites/production/files/documents/r8-src_src-dust-01.pdf

The following text was taken from High Volume Indoor Dust Sampling at Residences for Determination of Risk-Based Exposure to Metals:

SYNOPSIS: A standardized high-volume vacuum method for collection of indoor dust at residences is described. This method is suitable for measurement of either contaminant concentration (mg/kg) or contaminant loading (mg/m2) in indoor dust.

10.14 Sampling Asbestos

10.14.1 - Asbestos Sampling and Testing

http://www.cala.ca/sampling/14_Asbestos_Sampling_and_Testing.pdf

Asbestos Sampling
The following guidance is from the Environmental Protection Agency booklet, Asbestos in Your Home prepared by the American Lung Association, the Consumer Product Safety Commission (CPSC), and the EPA.

The website address for the booklet is

http://www.epa.gov/iedweb00/pubs/asbestos.html

Before taking an asbestos sample, call the laboratory that will run the test for advice about the sampling procedure, the amount needed and the container to use. "You can't tell whether a material contains asbestos simply by looking at it, unless it is labelled. If in doubt, treat the material as if it contains asbestos or have it sampled and analyzed by a qualified professional. A professional should take samples for analysis, since a professional knows what to look for, and because there may be an increased health risk if fibers are released. In fact, if done incorrectly, sampling can be more hazardous than leaving the material alone. Taking samples yourself is not recommended. If you nevertheless choose to take the samples yourself, take care not to release asbestos fibers into the air or onto yourself. Material that is in good condition and will not be disturbed (by remodeling, for example) should be left alone. Only material that is damaged or will be disturbed should be sampled.

10.15 Sampling Sport Fish for Contaminant Analyses

10.15.1 - Protocol for the Collection of Sport Fish Samples for Contaminant Analyses, Updated October 2013

Ontario Ministry of Environment
Shipping Address
Sport Fish Contaminant Monitoring Program
Ministry of Environment
Environmental Monitoring and Reporting Branch
125 Resources Road
Etobicoke, Ontario M9P 3V6
(416) 327-6816 or 1-800–820-2716

sportfish.moe@ontario.ca

http://www.cala.ca/sampling/32_Sample_protocol_2013-10_Without_Appendix.pdf

The following text was taken from the Protocol for the Collection of Sport Fish Samples:

The Sport Fish Contaminant Monitoring Program of the Ontario Ministry of the Environment has been monitoring various contaminants in Ontario fish since the late 1960s. The following sample collection procedures should be closely followed in order to ensure that data generated by the program is both consistent and meaningful.

Number of Fish
For each species, target 10 to 20 fish of a good size range (15-75+ cm) and, if possible, a mix of gender. Fish smaller than 15 centimeters in length (total length) should not be submitted, unless they are for a special study. For smelt, separate the fish into groups of
10 fish of approximately the same length. Five to ten composites samples of smelt per location should be collected. Please report average lengths and weights for these samples.

Sample Preparation
Samplers are requested to submit samples in skinless, boneless fillet form, rather than whole fish, for routine analyses. Normally a fillet sample consists of tissue from the epaxial muscle (see Figure 1) collected by making an initial incision with a clean stainless steel knife on the dorsal surface of the fish as shown (incision no.1). The epaxial muscle is then removed by cutting from the initial incision toward the tail (incision no.2) until a sufficient quantity of tissue is obtained. The muscle can be separated from the body by incision no.3. The skin is then removed from the fillet, and the sample is wrapped as described in the Packaging section. It is very important not to remove tissue from below the lateral line because of the high fat content in this region which makes PCB and organic analyses unrepresentative.

The sample should be frozen immediately after filleting and should be in this condition when shipped to the laboratory. Freezing is the only acceptable preservation technique.
Non-Agricultural Source Materials — Sampling and Analysis

APPENDICES

1. Acknowledgments

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Russell Martin
Andrew Morris
Kelley Neuert
Ensor Nicholson
Klas Ohman
Dr. Donald Reid
Peter Richards
Mélanie Robitaille
James Spankie
Dr. Chris Swyngedouw
Graham Tait
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Anne Vézina
Dr. Mel Webber

2. Documents provided by the Centre d'expertise en analyse environnementale du Québec

Direction des expertises et des études
Centre d'expertise en analyse environnementale du Québec
Ministère du Développement durable, de l'Environnement, de la Faune et des Parcs

2700, rue Einstein, bureau E-2-220
Québec (Québec), G1P 3W8
www.ceaeq.gouv.qc.ca

These excellent documents are available in the French language.

General note: all the sampling documents edited by the "Centre d'expertise en analyse environnementale du Québec" are available and free for download at :

http://www.ceaeq.gouv.qc.ca/documents/publications/echantillonnage.htm

General Sampling Guidelines

- Cahier 1 Généralités (Booklet 1 Generalities) from the Sampling Guide for Environmental Analysis, Québec's Ministry of Environment, 2008

MINISTÈRE DU DÉVELOPPEMENT DURABLE, DE L'ENVIRONNEMENT ET DES PARCS DU QUÉBEC, juillet 2008, Guide d'échantillonnage à des fins d'analyses environnementales : Cahier 1 – Généralités, Centre d'expertise en analyse environnementale du Québec, 58 p., 3 annexes, http://www.ceaeq.gouv.qc.ca/documents/publications/guides_ech.htm

- Training & Qualifications of Samplers

Example of training and experience requirements for the personnel undergoing waste-derived fertilizer sampling presented in: http://www.ceaeq.gouv.qc.ca/accreditation/paee/processus-mrf.pdf
p. 13

- Sampling Observation Reports

Cahier 1 Généralités (Booklet 1 Generalities) from the Sampling Guide for Environmental Analysis, Québec's Ministry of Environment, 2008

- Field Sampling Record Keeping (Logbooks)

Cahier 1 Généralités (Booklet 1 Generalities) from the Sampling Guide for Environmental Analysis, Québec's Ministry of Environment, 2008

- Health & Safety Guidelines for samplers

Cahier 1 Généralités (Booklet 1 Generalities) from the Sampling Guide for Environmental Analysis, Québec's Ministry of Environment, 2008

- Cleaning of sampling equipment
- Cahier 1 Généralités (Booklet 1 Generalities) from the Sampling Guide for Environmental Analysis, Québec's Ministry of Environment, 2008
- SESDPROC-205-R2, Field Equipment Cleaning and Decontamination, EPA, 2011

Consequences of Poor Sampling

- Sample contamination

Section 3 "Manipulation des objets servant à l'échantillonnage" in Cahier 1 Généralités (Booklet 1 Generalities) from the Sampling Guide for Environmental Analysis, Québec's Ministry of Environment, 2008

- Avoiding Sample Contamination

Cahier 1 Généralités (Booklet 1 Generalities) from the Sampling Guide for Environmental Analysis, Québec's Ministry of Environment, 2008

Sample preparation, pre-treatment & preservation

All the required information (sample volume, container, preservative, shipping temperature, holding times for each analytical parameter, for each matrix) is presented in thematic fascicules available in this page:
http://www.ceaeq.gouv.qc.ca/documents/publications/echantillonnage.htm

Wastewater : Modes de conservation pour l'échantillonnage de rejets liquides (eaux usées) DR-09-04 (12 juillet 2012)

Groundwater : Modes de conservation pour l'échantillonnage des eaux souterraines (DR-09-09)

Soil : Modes de conservation pour l'échantillonnage des sols (DR-09-02)

Surface water : Modes de conservation pour l'échantillonnage des eaux de surface (DR-09-10) - (19 juin 2012)

Pesticides : Modes de prélèvement et de conservation des échantillons relatifs à l'échantillonnage des pesticides (DR-09-06) (5 février 2013)

Sample identification and Labeling

Cahier 1 Généralités (Booklet 1 Generalities) from the Sampling Guide for Environmental Analysis, Québec's Ministry of Environment, 2008
And presented in every thematic booklet.

- Chain of Custody

Cahier 1 Généralités (Booklet 1 Generalities) from the Sampling Guide for Environmental Analysis, Québec's Ministry of Environment, 2008

Soil and Sediment Sampling

Cahier 5 Échantillonnage des sols (Soil sampling), 2009
http://www.ceaeq.gouv.qc.ca/documents/publications/echantillonnage/solsC5.pdf

Sediments: Guide d'échantillonnage des sédiments du Saint-Laurent pour les projets de dragage et de génie maritime, Environement Canada (27 février 2003)

- Volume 1 : Directives de planification
- Volume 2 : Manuel du praticien de terrain

- Definition of a representative sample

Cahier 1 Généralités (Booklet 1 Generalities) from the Sampling Guide for Environmental Analysis, Québec's Ministry of Environment, 2008

Water and Wastewater Sampling

Cahier 2 Échantillonnage des rejets liquides (21 juillet 2009) (Sampling of wastewater)
http://www.ceaeq.gouv.qc.ca/documents/publications/echantillonnage/rejets_liquidesC2.pdf

Note : Sampling of wastewater requires to determine the flowrate, which is the topic of Booklet 7 « Mesure du débit en conduit ouvert » http://www.ceaeq.gouv.qc.ca/documents/publications/echantillonnage/rejets_liquidesC2.pdf

Booklet 7 FLOW MEASUREMENT METHODS IN OPEN CHANNELS

http://www.ceaeq.gouv.qc.ca/documents/publications/echantillonnage/debit_conduit_ouv_C7_ang.pdf

Visit page http://www.ceaeq.gouv.qc.ca/documents/publications/echantillonnage.htm to see the addenda to Booklet 7

Groundwater Sampling

Booklet 3 Groundwater Sampling:
MINISTÈRE DU DÉVELOPPEMENT DURABLE, DE L'ENVIRONNEMENT ET DES PARCS DU QUÉBEC, 2012, Sampling Guide for Environmental Analysis: Booklet 3 – Sampling Groundwater, Centre d'expertise en analyse environnementale du Québec, 54 p., 1 appendix.
http://www.ceaeq.gouv.qc.ca/documents/publications/echantillonnage/eaux_soutC3_ang.pdf

- Freshwater Sampling

Suivi de la qualité de l'eau des rivières et petits cours d'eau, 2000
http://www.mddefp.gouv.qc.ca/eau/eco_aqua/rivieres/sommaire.htm
http://www.mddefp.gouv.qc.ca/eau/eco_aqua/rivieres/GuidecorrDernier.pdf

Hazardous material sampling (waste sampling)
Cahier 8 Échantillonnage des matières dangereuses (updating process ongoing, title will be changed to Cahier 8 Échantillonnage des matières résiduelles (waste material)
http://www.ceaeq.gouv.qc.ca/documents/publications/echantillonnage/mat_dang_C8.pdf

Air and Air Emissions Sampling

Ambiant air sampling
Booklet 9 Ambiant air sampling (to be published)

- Hi Volume Particulate Sampling

Included in Booklet 9 Ambiant air sampling

- Stationary Air Emissions Sampling

Booklet 4 SAMPLING OF ATMOSPHERIC EMISSIONS FROM STATIONARY SOURCES (updating process starting in 2014)
MINISTÈRE DU DÉVELOPPEMENT DURABLE, DE L'ENVIRONNEMENT ET DES PARCS DU QUÉBEC. Sampling Guide for Environmental Analysis: Booklet 4 – Sampling of Atmospheric Emissions from Stationary Sources, Québec, Centre d'expertise en analyse environnementale du Québec, 2009
http://www.ceaeq.gouv.qc.ca/documents/publications/echantillonnage/emiss_atm_fixesC4_ang.pdf

- Indoor Dust Sampling

Forage sampling for Fluoride Analysis

MINISTÈRE DU DÉVELOPPEMENT DURABLE, DE L'ENVIRONNEMENT ET DES PARCS DU QUÉBEC, 2006,Sampling Guide for Environmental Analysis: Booklet 6 – Forage Sampling for Fluoride Analysis, Centre d'expertise en analyse environnementale du Québec, 21 p., 2 appendixes,
http://www.ceaeq.gouv.qc.ca/documents/publications/echantillonnage/fourrage_fluoruresC6_ang.pdf

Legionellosis
Protocole d'échantillonnage de l'eau du circuit des tours de refroidissement pour la recherche des légionelles (DR-09-11) (18 avril 2013) (Cooling towers water sampling for legionella analysis)

2. Échantillonnage à des fins d'analyses environnementales

Les cahiers d'échantillonnage décrivent les bonnes pratiques pour planifier et réaliser l'échantillonnage afin d'assurer la qualité des échantillons et la validité des résultats. Ces documents s'adressent aux responsables des campagnes d'échantillonnage et aux préleveurs. Le Cahier 1, Généralités, doit accompagner chacun des cahiers subséquents.

Les documents de modes de conservation déterminent les agents de conservation, les contenants, les quantités et les délais de conservation associés à chaque type d'échantillon et d'analyse.

•Cahier 1 : Généralités (juillet 2008)

•Cahier 2 : Échantillonnage des rejets liquides (21 juillet 2009)

◦Fascicule : Modes de conservation pour l'échantillonnage de rejets liquides (eaux usées) DR-09-04 (12 juillet 2012)

•Cahier 3 : Échantillonnage des eaux souterraines (23 février 2012) (version anglaise)

◦fascicule : Modes de conservation pour l'échantillonnage des eaux souterraines (DR-09-09) (19 juin 2012)

•Cahier 4 : Échantillonnage des émissions atmosphériques en provenance de sources fixes (21 juillet 2009) (version anglaise)

•Cahier 5 : Échantillonnage des sols (5 février 2010)

◦fascicule : Modes de conservation pour l'échantillonnage des sols (DR-09-02) (22 janvier 2013)

•Cahier 6 : Échantillonnage du fourrage pour l'analyse des fluorures (août 2008) (version anglaise)

•Cahier 7 : Méthodes de mesure du débit en conduit ouvert (août 2008) (version anglaise)

◦ addenda 1 : Vérification de l'exactitude d'un système de mesure du débit ou du volume d'eau in situ à l'aide d'un appareil étalon (1 février 2012)
◦ addenda 2 : Vérification de l'exactitude d'un système de mesure du débit ou du volume d'eau dans des conduits ouverts ou sous pression - Précisions relatives au rapport à produire
◦ section 5.1.3 : Protocole d'application de la méthode de mesure de débit par dilution d'un traceur à débit constant
◦ section 5.4.6.1 : Protocole d'utilisation du moulinet hydrométrique
•Cahier 8 : Échantillonnage des matières dangereuses (septembre 2008)
◦fascicule : Modes de conservation des échantillons relatifs à l'application du Règlement sur les matières dangereuses (DR-09-01) (16 novembre 2011)

Échantillonnage pour la recherche de légionelles
• Protocole d'échantillonnage de l'eau du circuit des tours de refroidissement pour la recherche des légionelles (DR-09-11) (18 avril 2013)

Modes de conservation en lien avec un règlement

• Modes de conservation des échantillons relatifs à l'application du Règlement sur les exploitations agricoles (DR-09-12) (25 octobre 2010)
• Méthodes de prélèvement, de conservation et d'analyse des échantillons relatifs à l'évaluation de la qualité de l'eau des piscines et autres bassins artificiels (DR-09-05) (10 septembre 2009)
• Modes de prélèvement et de conservation des échantillons relatifs à l'application du Règlement sur la qualité de l'eau potable (maintenant à l' annexe 4 du Règlement sur la qualité de l'eau potable)

Modes de conservation - autres
• Modes de conservation pour l'échantillonnage des eaux de surface (DR-09-10) - (19 juin 2012)
• Modes de prélèvement et de conservation des échantillons relatifs à l'échantillonnage des pesticides (DR-09-06) (5 février 2013)
Autres guides d'échantillonnage (sites externes)

Échantillonnage de l'eau de surface

•Échantillonnage de l'eau des rivières et petits cours d'eau
Suivi de la qualité de l'eau des rivières et petits cours d'eau
•Échantillonnage de l'eau de surface pour l'analyse des métaux en traces
Protocole d'échantillonnage de l'eau de surface pour l'analyse des métaux en traces
•Échantillonnage de l'eau d'un lac pour évaluer son eutrophisation
Protocole d'échantillonnage de la qualité de l'eau - protocole élaboré dans le cadre du Réseau de surveillance volontaire des lacs
•Échantillonnage de l'eau d'un lac pour évaluer sa qualité microbiologique
Guide pour l'évaluation de la qualité bactériologique de l'eau en lac
Échantillonnage de l'eau potable
• Annexe 4 du Règlement sur la qualité de l'eau potable (RQEP)

Échantillonnage des macroinvertébrés benthiques
• Guide de surveillance biologique basée sur les macroinvertébrés benthiques d'eau douce du Québec
Échantillonnage des matières résiduelles fertilisantes
•Protocole d'échantillonnage de matières résiduelles fertilisantes - Résidus de fabriques de pâtes et papiers et autres
résidus solides
Échantillonnage des précipitations
• Programme de surveillance de la qualité des précipitations
Échantillonnage des sédiments

•Guide d'échantillonnage des sédiments du Saint-Laurent pour les projets de dragage et de génie maritime (27 février 2003)
◦Volume 1 : Directives de planification
◦Volume 2 : Manuel du praticien de terrain

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