Professional Engineers
Ontario

GUIDELINE

Professional Engineers Providing Services in Environmental Site Assessment, Remediation and Management

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CONTENTS

1. INTRODUCTION

1.1 Purpose

This document is a guideline for providing services relating to environmental site assessment (ESA), remediation and management. It recognizes the multidisciplinary nature of such work. This guideline is intended to assist professional engineers but does not replace existing legislation, regulations, policies and guidelines, or obviate the need for appropriate education, training and experience.

1.2 Responsibilities

Professional engineers involved in site assessment and remediation must be familiar with federal, provincial and municipal legislation, regulations, policies and guidelines that apply to their particular discipline or area of expertise. Permitting processes, approvals requirements and compliance issues will vary, depending on the site and the remediation technology employed.

Beyond these responsibilities, professional engineers are also required to conduct themselves in a manner consistent with the Professional Engineers Act.

2. PHASE I ENVIRONMENTAL SITE ASSESSMENTS

2.1 Objective

Phase I ESAs are intended to help determine potential environmental liabilities and to establish the basis for further investigative work by:

- identifying certain baseline environmental conditions;
- assisting in meeting regulatory, legislative and policy requirements, by identifying compliance deficiencies, and serving as an initial step in site remediation plan preparation; and
- providing the necessary information to make informed decisions about property transactions.

2.2 Study Considerations

Phase I ESAs should be conducted using appropriate methodologies for the objectives in the scope of work, including the use of standardized and generally–agreed–upon procedures. Sufficient information should be obtained, evaluated, and presented to support the professional engineer's conclusions.

The four principal components of a Phase I ESA are:

- records review;
- site visit;
- interviews; and
- evaluation of information and reporting.

The requirements, methodology, and practices are more fully described in the CSA document Z768-94. The CSA document also delineates the appropriate combination of formal education, skill, experience and training to provide a technically sound Phase I ESA.

3. PHASE II ENVIRONMENTAL SITE ASSESSMENTS

3.1 Objective

The objective of a Phase II ESA is to characterize or delineate environmental conditions related to a property.

It is the professional engineer's responsibility to carry out a detailed enough investigation to identify, characterize, or delineate the nature and extent of contamination both above and below grade on the property.

3.2 Study Considerations

The principal components of a Phase II ESA are:

- development of investigation and sampling work plans;
- investigations and inspections; and
- interpretation and reporting of sampling results.

A Phase II ESA should be as detailed as necessary for the purpose of the study. It should be guided by such information as:

- the types of activities, processes and practices that have occurred on the site and on neighbouring sites;
- the framework of legislation and published guidelines that apply to the property;
- the amount and quality of pre-existing information on the site's potential contamination;
- such site-specific conditions as soil type, depth to ground water, direction and rate of ground water flow, ground water quality, surface water quality, sediment quality and depth to bedrock;
- the type and quantity of information required to design an appropriate remediation program; and
- the potential presence of designated substances, solid, liquid or hazardous wastes, raw materials, products and other dangerous goods.

3.2.1 Inherent Limitations

The client and other stakeholders should be apprised of the limitations of Phase II ESA work. These may include:

- failure to detect;
- inadequate background information;
- errors by third parties;
- delineation limited by budget, access and/or time;
- the site's nature and constraints; and
- other considerations, e.g. environmentally sensitive areas, access control, safety concerns, operational limitations.

3.3 Phase II ESA Practices

3.3.1 Investigation and Sampling Work Plan

The professional engineer should develop a work plan detailing investigation and sampling procedures and applicable health and safety considerations. The plan is intended to provide a detailed description of the sampling and measuring to be conducted during a Phase Il ESA.

Site limitations should be identified and the plan should:

- incorporate these limitations;
- be designed to avoid further impact on the environment or the site becoming a pathway for contaminants to migrate;
- clearly state the objectives of the investigation or sampling effort;
- identify the location of each sample or measurement, perhaps on a site map;
- include specific sampling or measuring methods, the number of samples or measurements, the

parameters being sampled or measured, a description of the objectives for each sampling or measuring activity, and details of the methodologies to be used for sample or measurement collection, preservation, transportation and analysis; and

- consider the merits of a quality assurance/quality control (QA/QC) program.

The methods used will be influenced by the types and concentrations of contaminants encountered or suspected to be present, and by the environmental media to be sampled. Specific methods can range from non-intrusive field screening to more complex, intrusive media sampling.

Since the nature and extent of potential contamination may not be identified from file review and site observation, field screening techniques may provide an indication of the presence or absence of contaminants. The objective of field screening is not to quantify the magnitude and define the extent of contamination precisely, but rather to provide data in sufficient amount and quality to determine whether contamination is present and to guide the implementation of intrusive sampling methods and the submission of samples for analysis.

Professional engineers should use their judgment to determine the types and numbers of samples and measurements to be taken during a Phase II ESA.

3.3.2 Undertaking Site Investigations

All work must be conducted with appropriate regard for the health and safety of the individuals undertaking the investigation and sampling, as well as the health and safety of the workers at the site and the public in the vicinity. It is the professional engineer's responsibility to communicate clearly potential hazards of the site under investigation to everyone engaged in the investigation. The professional engineer must ensure that operational requirements to maintain investigation safety are enforced. A safety plan should be prepared before initiating sampling.

Environmentally sensitive features should be identified and appropriately mitigated before any physical work is undertaken.

The site investigation should be documented using appropriate methods, including but not limited to field logbooks, photographs and videos.

During a site investigation, conditions may be discovered that require deviations from the sampling plan. The deviation and its rationale should be documented. Discussions with the client and regulatory agencies may be necessary to decide how to respond to deviations.

It is the professional engineer's responsibility to ensure that all samples are collected, transported and analyzed in a manner consistent with the investigation's requirements and all applicable guidelines, taking into account such considerations as:

- cross contamination;
- detection limits and analytical techniques;
- sample collection, preservation and handling;
- selection of reference criteria;
- chain of custody;
- laboratory accreditation; and
- QA/QC.

People and equipment should be decontaminated, if necessary, before leaving the property.

3.3.3 Interpretation and Reporting of Sampling Results

The professional engineer should evaluate the information obtained during site investigation and present it in a manner designed to help the client understand its significance. To do this, the professional engineer should:

- summarize data and describe general trends or patterns;
- use maps and site cross sections to show spatial patterns of contamination;
- draw attention to those data that indicate conditions of concern;
- point out possible inconsistencies or anomalies in the data;

- indicate the relative degree of uncertainty associated with evidence of potential contamination; and
- identify any limiting conditions that arose during the Phase II process.

If the client specifies, the professional engineer may also:

- identify any further investigation, sampling, or inspection required to delineate the extent of contamination or to develop a proper remedial action plan; and
- provide a preliminary scope of work and cost estimate for possible remedial activities.

The professional engineer or the individuals in charge of the team that performs the Phase II ESA should provide original signatures confirming the performance of the Phase II ESA, its findings and conclusions. They should declare in the report any conflict of interest.

A statement of the qualifications of the professional engineer responsible for the Phase II ESA may also be included, as well as representations and warranties.

3.4 Qualifications

A professional engineer shall possess a combination of formal education, skill, experience and training appropriate to provide a technically sound Phase II ESA.

In the matter of competence relating to PEO licensees:

- Section 72(2)(h) of *Regulation 941/90* states: “Professional misconduct means undertaking work the practitioner is not competent to perform by virtue of the practitioner’s training and experience.”
- Environmental Guideline Number 2, which deals with the interdisciplinary approach, states: “a professional engineer shall seek out and use as necessary the supplemental expertise of specialists to assess the environmental implications of engineering activities, and should:
  - recognize that environmental issues are interdisciplinary in nature;
  - undertake only work that the engineer is competent to perform by virtue of training and experience;
  - recognize individual limitations in the assessment of environmental effects;
  - have regard for the professional opinions of environmental specialists in other disciplines.”

4. SITE REMEDIATION

The results of the Phase II assessment outlined in Section 3 should be sufficient to provide a representative description of the media/materials requiring remediation or management, by defining the contamination’s nature, quantity, area, vertical distribution and location. Site management is discussed in Section 5.

4.1 Objectives

The objective of remediation is most often to return an impacted property/site to an environmental condition that will sustain its intended reuse. Alternatively, the objective can be to secure the site in a manner that mitigates or prevents future adverse impacts.

4.2 Clean-up Targets

Generally, there are three approaches that can be used to determine the clean-up level to be achieved during site remediation. These three options, as discussed by the Ministry of Environment and Energy (MOEE), are:

1. clean-up to background condition;
2. clean-up for compliance with generic criteria; or

3. clean-up to criteria developed using site-specific risk assessment (SSRA) techniques.

In principle, clean-up to background can be used for any site. It is essentially a remedial strategy that restores the property to an environmental condition consistent with the ambient or background conditions. In practice, such an approach is seldom, if ever, adopted.

Clean-up criteria have been developed by several government agencies to assist proponents in establishing criteria that are protective of human health and/or the environment (see Section 7.3). Generic criteria are most commonly developed for such media as soil, ground water, surface water, air and sediment. These so-called "generic" criteria were developed for a range of applications, including different land uses, land-use sensitivity, depth of contamination, and surface water or ground water use. The professional engineer needs to be aware of these generic criteria's limitations, in order to apprise the proponent of the relative merits of this approach to site remediation.

A site management or remedial approach based on site-specific risk assessment may be used to optimize site remediation for a particular site, based on conditions at that site. See Section 6.1 of this guideline for further detail.

The decision process and logic used to select criteria should be documented as part of the documentation on site clean-up and remediation.

4.3 Development and Screening of Remedial Alternatives

This step in site remediation generates a range of alternatives for subsequent detailed analysis. Alternatives that ensure the protection of human health and the environment may involve the complete elimination or destruction of hazardous materials, reduction of concentrations to acceptable levels, prevention of exposure to hazardous materials through engineering or institutional controls, or some combination of the above.

Development and screening of alternatives may be conducted concurrently, or simultaneously, with site investigation and the establishment of remediation targets, since screening alternatives can identify the need for additional site investigation to assess a particular alternative.

The professional engineer develops alternatives for site remediation by assembling combinations of technologies and the media to which they apply into alternatives that satisfy the clean-up objectives. The screening process should consider the interaction among alternatives for each media type, to ensure they are compatible.

At the screening stage, alternatives are typically evaluated for their technical effectiveness, implications regarding long-term liability, implementability and cost, based on the information available. The potential to achieve regulatory approval and likelihood of public acceptance are other common screening factors.

4.3.1 Treatability Studies and Pilot Tests

During screening alternatives, questions commonly arise on the application of a particular technology or process to the unique matrices under study. Treatability studies and pilot tests are therefore sometimes conducted as part of evaluating alternatives, to assess whether a particular technology is technically feasible, meets project objectives, and is cost effective.

The value of the information obtained by conducting treatability studies and pilot tests must be weighed against the cost and time required. If significant cost savings can be achieved or if uncertainties can be reduced to tolerable levels, treatability studies are warranted.

4.3.2 Detailed Analysis of Remediation Alternatives

In detailed analysis, remediation alternatives retained through screening are subject to further development, to help evaluate them in greater detail. Alternatives may be refined based on the results of further site characterization or treatability work, and should provide decision makers with the necessary information to select a preferred alternative.

A preferred alternative is selected by weighing the advantages and disadvantages of the various alternatives, the trade-offs among alternatives, and the relative risk the proponent is willing to accept. This often involves striking a balance between costs and risk tolerance.

4.4 Design of Site Remediation Plan

Once a preferred alternative is selected, it is developed to the detailed design or remedial design stage.

It may be desirable to prepare a site remediation plan that provides a description of the project to the preliminary design stage. Since such a document would describe the plans for implementing the selected alternative, it can serve as a basis for discussing the project's implementation stage with the proponent, regulatory agencies, or stakeholders.

A site remediation plan would normally include:

- description of remedial objectives, including specifying clean-up criteria to be achieved;
- overview of site contamination;
- description of media/materials to be remediated;
- the options(s) that appear to be best suited for remediating specific conditions;
- description of issues resolution process;
- the types of bench-or pilot-scale tests, if needed, to confirm the viability of specific options or the designs of treatment equipment;
- estimates of the time required to initiate and complete remediation;
- preliminary estimates of remediation costs;
- description of remedial strategy;
- description of regulatory approval requirements;
- public communications plan;
- construction plans;
- design and tendering of remediation;
- management of accumulated water, dust, noise and traffic;
- environmental/emission monitoring;
- confirmatory sampling;
- health and safety plan;
- contingency plans;
- long-term monitoring;
- mobilization and site preparation;
- materials handling;
- management of by-products;
- project schedule/duration;
- site restoration /demobilization; and
- reporting/documentation requirements.

Detailed construction/remediation drawings are typically developed at this stage of the project. Drawings should be sufficiently detailed to allow a remediation contractor to implement the project. These drawings are used as the basis for soliciting bids for implementing the project, and may also be required to support applications for regulatory approvals.

4.5 Implementation of Site Remediation Plan

The remediation plan may involve applying for permits and approvals for decontamination or demolition of building infrastructure and/or equipment, as well as for remediation/treatment of solid, liquid or gaseous matrices (i.e. soil, sediment, sludge, surface water, ground water, or soil gas).

4.5.1 Preparation of Specifications and Tender Documents, Contractor Selection

Typically, specifications provide a thorough description of the remediation work to be performed. Specifications may be in the form of written instructions, engineering drawings, or both. Detailed specifications are used when the remediation method is well defined and not open to alternatives developed by the remediation contractor. A performance specification is used when the end goal is well defined, but there are numerous ways to achieve the goal, any of which is considered acceptable to the proponent. Combinations of detailed and performance specifications can also be used as appropriate.

4.5.2 On-site Supervision

On-site supervision is usually essential during clean-up, to ensure the proponent's interests are addressed and to develop verification information. The proponent or an agent for the proponent can provide the supervisor. The on-site supervisor's role may include:

- ensuring that the contractor adheres to approved plans and specifications;
- recording use of personnel and materials on site, if the contract's payment is based on time and materials;
- recording extras that will increase the cost of the project, if the contractor's payment is lump sum for a defined scope of work. Extras should be undertaken only after approval by the on-site supervisor and/or the proponent;
- monitoring the contractor's on-site health and safety program;
- acting as the proponent's representative on site generally;
- documenting the nature and progress of the remediation on behalf of the proponent; and
- ensuring compliance with all applicable environmental regulations.

The professional engineer should check the remediation progress periodically, to monitor the contractor's work and to ascertain whether clean-up objectives are being met. This may involve verification sampling of excavations, treated materials, discharged materials, materials disposed of as waste and imported materials.

4.5.3 Alternative Project Delivery

The proponent may wish to implement the remediation using an alternative project delivery method, instead of the conventional approach. In this situation, the role of the professional engineer may include:

- project financing;
- design/build and turnkey delivery;
- contract operations; or
- own/construct/operate.

4.6 Verification, Documentation, Registration

As distinct phases of the site remediation plan are completed, verification sampling of the remediated areas/materials should be carried out, to ensure that contamination has been effectively remediated.

4.6.1 Documentation

After verifying that clean-up has been satisfactorily completed, remedial efforts and verification samples should be thoroughly documented. The description of the remedial works and their satisfactory completion must be supported by verification data. Documentation must be sufficient to demonstrate that the remedial objectives were achieved.

The professional engineer or individuals in charge of the team that supervises the site remediation should provide original signatures confirming the performance of the site remediation plan, its findings and conclusions. A statement of the qualifications of the professional engineer responsible for supervising the site remediation should be included in the report. The professional engineer shall declare in the report any conflict of interest. The professional engineer must fulfill any reporting requirements under the permit and/or regulatory authority, if they are within the scope of work.

4.6.2 Registration

Registering post-remediation site conditions on land title may be required, to document the nature of the remediation and any residual contamination. Documentation prepared by the professional engineer is likely to form the basis for developing this registration.

4.7 Qualifications

A professional engineer shall possess a combination of formal education, skill, experience and training appropriate to provide a technically sound site remediation.

5. SITE MANAGEMENT

During development of the site remediation plan, it may become apparent that immediate remediation of contamination to applicable clean-up standards may be inappropriate. This can occur when:

- there is no imminent unacceptable risk to public health and safety or to the environment, because contamination is immobile and localized on site, with no impact beyond the property lines;
- the site is continuing to operate in its current mode and no change to a more sensitive land use is planned;
- remediation is not practical, given the depth and location of the contaminants (e.g. removal of contamination is inhibited by such existing structures as buildings, surface equipment, underground tanks, or utilities); or
- a planned future redevelopment of the site will facilitate more effective and more efficient remediation.

In these types of situations, the proponent may elect to proceed with a site management program, instead of immediate site remediation. Site management requires regulatory approval. It may be a temporary solution aimed at control of the site. Site management may include undertaking hydraulic or vapour control measures, a monitoring program, or possibly a risk analysis to define the potential environmental risk.

6. SPECIAL SERVICES

6.1 Risk Assessment and Risk Management

During the course of assessing, remediating, or managing sites, it may be necessary or helpful to estimate the potential risks to people or other types of organisms if they come into contact with chemicals present in the environment.

Assessing risks can help determine when conditions need to be improved, so that risks can be reduced, clean-up objectives that correspond to a certain level of risk can be set, and clean-up priorities based on risk estimates can be assigned.

The professional engineer may need to use many types of information in a risk assessment, including information on how contaminants behave in the environment, their adverse effects, site characteristics, and characteristics of the people or organisms being assessed. Mathematical models are often used to estimate the extent to which receptors come into contact with chemicals. The findings are usually expressed in terms of the likelihood of adverse effects occurring for various combinations of receptors, exposure pathways and chemicals.

The process of identifying the extent of risk associated with alternative solutions and then making an appropriate selection is referred to as risk management. Decisions to manage risks can be influenced by such considerations as economics, public expectations and technological capabilities. Although risk assessment and risk management have distinctly different objectives, there is a tendency to use risk assessment to refer to both.

In Ontario, the MOEE has acknowledged that risk assessment techniques can be used to derive site-specific clean-up guidelines. Recent MOEE documents use the term “site-specific risk assessment”, or SSRA, to describe an approach that incorporates site-specific considerations in developing soil and ground water clean-up criteria (see Section 7.3 of this guideline). The MOEE describes four conditions under which a SSRA approach may be used:

1. at potentially sensitive sites, to develop clean-up criteria that are more protective than the generic criteria provided by the MOEE;
2. to develop site-specific criteria for contaminants for which generic criteria are not provided;
3. to develop site-specific criteria in lieu of the generic criteria provided by the MOEE; or
4. to develop a risk management/site management plan.

The MOEE documents also provide general guidance on areas that should be considered when undertaking a SSRA, characteristics that define potentially sensitive sites, and administrative requirements that are part of the SSRA approach. For example, an SSRA report is to be peer reviewed by a qualified independent practitioner before it is reviewed by risk assessment staff at the MOEE.

Regardless of whether a risk assessment is prepared for an SSRA or for another application, each risk assessment has the potential to pose numerous challenges to the assessors. For example, risk assessments are often complex exercises, involving numerous combinations of receptors, pathways and chemicals. Limitations in the available data often require assumptions to be made and supported. Communicating the results of a risk assessment often warrants special care, since experience has shown that risk-related concepts are difficult to present.

The overall result is that managers of risk assessment projects should have the necessary experience and background to provide them with a sound understanding of the risk assessment process, familiarity with the various disciplines that are part of the assessment, the ability to coordinate the work of specialists, and an appreciation of the inherent limitation of risk assessment.

Since risk assessment has the potential to be a keystone in site remediation and management plans, people responsible for finalizing or approving risk assessments must understand the work thoroughly. In the context of a SSRA, the risk assessment project manager may be required to sign documents or affidavits that characterize the site, describe the findings of the risk assessment, or summarize the risk management measures to be taken.

6.2 Expert Testimony

The process of site remediation and management sometimes requires the expert testimony of professional engineers at regulatory hearings, courts of law, inquest hearings and discoveries, through interrogatories, and before committees. Such testimony shall be confined to expert testimony within a professional engineer's realm of experience, chosen discipline and expertise. It may also involve directly advising legal counsel before, during, and after hearings, and during discoveries and interrogatories. The purpose of expert testimony is to provide unbiased truthful information to assist the judge, board, or jury in reaching a sound decision. Professional engineers should refer to PEO's guideline The Professional Engineer as an Expert Witness for further guidance on this subject.

6.3 Presentation at Public Meetings

The professional engineer must have a comprehensive understanding of the subject, and must impart this in a manner the public can readily understand. Information must be truthful and unbiased.

When a significant public process is required, the professional engineer should consider a team approach, using a lawyer, planner or media consultant(s), to ensure effective public communication.

6.4 Advisory Services

Professional engineers may be retained to provide advisory services to stakeholders objecting to a proposed site assessment, remediation, or management project. Professional engineers shall be aware of their responsibilities under the Code of Ethics when reviewing another engineer's work and shall comply with these responsibilities. Other professional engineers may have similar responsibilities.

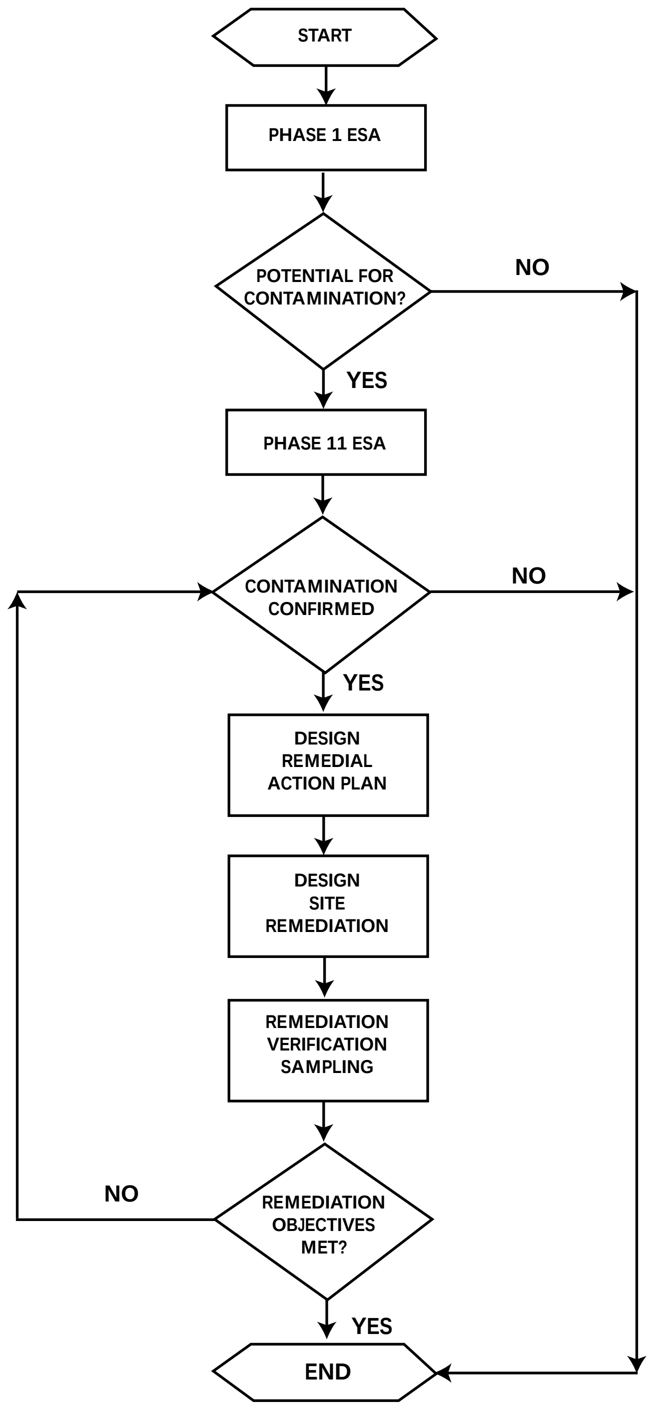
Professional engineers may be engaged to provide advisory services or peer review. Clients may be third parties (such as community groups, prospective property buyers, regulatory agencies, or property owners). In this case, the professional engineer's role is to verify the work of other professional engineers, and to provide an independent report to the client.

7. APPENDIX

7.1 Process Overview

Figure 1provides an overview of the environmental site assessment, site remediation and site management processes.

Figure 1. Environmental Site Assessment and Remediation Process



7.2 Definitions

For the purposes of this guideline:

Phase I Environmental Site Assessment (ESA) is the systematic process by which a professional engineer seeks to determine whether a particular property is or may be subject to actual or potential contamination, and the likely nature and location of the contamination. The process involves gathering and examining documents, maps and verbal information pertaining to a site. A Phase I ESA does not involve the investigative procedures of sampling, analyzing, and measuring.

Property comprises land and the improvement of any physical object with some degree of permanence. The terms property and site are used interchangeably in this guideline.

Phase II Environmental Site Assessment is a systematic process by which a professional engineer seeks to characterize and delineate the extent of a property's contamination, by means of intrusive investigations, including surveys, excavating, sampling and analyses, and to provide information to enable a decision on whether site remediation is required. A Phase II ESA does not involve implementing any remedial activities.

Contamination may generally be considered to be a non-naturally occurring concentration of a compound that might adversely affect the public or the environment. Contamination may be present at a site due to the site's historical operation, for example in areas where there has been extensive historical industrial operations, a diversity of prior industrial land use, or significant infilling. Contamination may be present due to spills, leaks or discharges, deposition of by-products or residues, or the cumulative effects of airborne deposition, subsurface migration or direct application or burial.

Site remediation is intended to restore a site's environmental condition to a level that is suitable for reuse.

Site management is intended to ensure that existing contamination is stabilized or contained in such a manner that it does not pose an unacceptable risk to the public and to the environment.

7.3 Guidelines

The professional engineer shall be knowledgeable of all relevant federal, provincial and municipal legislation, guidelines and policies.

In Ontario, the assessment and clean-up of contaminated sites is primarily governed by a set of guidelines developed by the Ministry of Environment and Energy, consistent with the Environmental Protection Act. The guidelines and companion documents describing the assessment and remediation procedures include:

1. *Interim Guidelines for the Assessment and Management of Petroleum Contaminated Sites in Ontario,* August 1993
2. *Guidelines for the Decommissioning and Clean-up of Sites in Ontario*, February 1989
3. *Proposed Guidelines for the Clean-up of Contaminated Sites in Ontario,* July 1994
4. *Guidance for the Use of Risk Assessments in Site Clean-ups in Ontario,* May 1994
5. *Guidance on Sampling and Analytical Methods for Site Clean-ups in Ontario,* May 1994
6. *Rationale for the Development and Application of Generic Soil, Ground Water, and Sediment Criteria for Cleanup of Contaminated Sites*, May 1994

Other relevant guidelines include:

1. *Interim Canadian Environmental Quality Criteria for Contaminated Sites (CCME EPC-CS34),* Ottawa: Canadian Council of Ministers of the Environment (CCME), September 1991.
2. *Subsurface Assessment Handbook for Contaminated Sites (CCME EPC-NCSRP-48E),* March 1994.
3. *Guidance Manual on Sampling, Analysis and Data Management for Contaminated Sites, Volumes I (Main Report) and II (Analytical Method Summaries) (CCME EPC-NCS62E),* December 1993.
4. *Phase I Environmental Site Assessment*, Toronto: Canadian Standards Association, April 1994.
5. *Non Profit Housing, Environmental Site Assessment Review Handbook,* Ontario Ministry of Housing, November 1993.
6. *Non-Profit Housing, Remedial Site Assessment Content and Format Guidelines,* Ontario Ministry of Housing, November 1993

7.4 References

1. *Phase I Environmental Site Assessment, CSA Standard Z768-94,* Toronto: Canadian Standards Association, April 1994.
2. *Standard Practice for Environmental Site Assessments: Phase I Environmental Site Assessment Process, ASTM Standard E 1527-94*, Philadelphia, PA.: American Society for Testing and Materials, 1994.
3. *Phase I ESA Interpretive Guideline,* Ottawa: CMHC, The Canadian Mortgage and Housing Corporation, June 1994.
4. Ontario MBS *Contaminant Recognition and Management,* Environmental Advisory Services Unit, Realty Group, July 1993.
5. *Guideline for a Professional Engineer's Duty to Report*, Toronto: Professional Engineers Ontario, 1990.
6. *Phase II Guideline*, Toronto: Canadian Standards Association.
7. *Subsurface Assessment Handbook for Contaminated Sites (CCME EPC-NCSRP-48E),* Ottawa: Canadian Council of Ministers of the Environment, March 1994.
8. *Interim Guidelines for the Assessment and Management of Petroleum Contaminated Sites in Ontario,* Toronto: Ministry of Environment and Energy (MOEE), August 1993.
9. *Proposed Guideline for the Clean-up of Contaminated Sites in Ontario,* Toronto: MOEE, July 1994.