

Public guideline on site remediation for engineers

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National Guideline - March 2018

Notice

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The national guidelines and Engineers Canada papers do not establish a legal standard of care or conduct, and they do not include or constitute legal or professional advice.

In Canada, engineering is regulated under provincial and territorial law by the engineering regulators. The recommendations contained in the national guidelines and Engineers Canada papers may be adopted by the engineering regulators in whole, in part, or not at all. The ultimate authority regarding the propriety of any specific practice or course of conduct lies with the engineering regulator in the province or territory where the engineer works, or intends to work.

About this Engineers Canada paper

This national Engineers Canada paper was prepared by the Canadian Engineering Qualifications Board (CEQB) and provides guidance to regulators in consultation with them. Readers are encouraged to consult their regulators' related engineering acts, regulations and bylaws in conjunction with this Engineers Canada paper.

About Engineers Canada

Engineers Canada is the national organization of the provincial and territorial associations that regulate the practice of engineering in Canada and license the country's 295,000 members of the engineering profession.

About the Canadian Engineering Qualifications Board

CEQB is a committee of the Engineers Canada Board and is a volunteer-based organization that provides national leadership and recommendations to regulators on the practice of engineering in Canada. CEQB develops guidelines and Engineers Canada papers for regulators and the public that enable the assessment of engineering qualifications, facilitate the mobility of engineers, and foster excellence in engineering practice and regulation.

1. Introduction

Engineers are required to conduct themselves in a manner consistent with their registration under provincial and territorial engineering Act(s) that regulate the practice of engineering. These Acts establish the engineering regulator that serves as the licensing authority for engineers practicing within each jurisdiction and, through certification and licensure, ensure only properly qualified members are allowed to practice and do so according to professional standards.

Each engineering regulator institutes standards and processes to ensure that engineers are competent and that their practice is skilled and ethical. This self-regulation and mutual accountability within the engineering regulator and among peers must be stringent, so that engineers merit societal trust. The engineering Code of Ethics holds the protection of the public from unethical and/or incompetent practice in highest esteem, and includes:

- » **Technical requirements:** ensuring that engineers protect public safety and well-being, and engage in skilled practice.
- » **Continuing competence:** concerning personal professional development and adherence to standards and guidelines in all areas of professional practice.
- » **Regulation and control:** enforcing against non-licensed and non-qualified persons and reviewing the practice of licensed members and permit holders.
- » **Discipline:** disciplining engineers who fail to comply with proper standards of professional practice and ethical conduct.

Technical and professional standards of conduct are set, revised, maintained, and enforced by the engineering regulators for their registered engineers. Engineers Canada is the national federation of the engineering regulators, and provides a coordinating function fostering mutual recognition among them and encouraging the greatest possible commonality of operation.

Engineers Canada issues national guidelines on various subjects to support the development of common practice guidelines among the engineering regulators, and support the continued qualification of engineers after initial licensure. This guideline for site remediation has been prepared by the Canadian Engineering Qualifications Board in consultation with the engineering regulators to assist engineers in carrying out their paramount responsibility to protect the public and environment, reflecting professional and ethical engineering and current and best practices and policies.

2. Purpose and scope

The purpose of this national guideline is to assist engineers involved in site remediation to address their professional and ethical responsibilities related to engineering design and project management. It addresses the responsibilities of engineers for professional services that generally involve the completion and/or review of reports and plans that pertain to the planning, design, execution, and auditing of site remediation work that normally follows completion of a site assessment. The services also include the preparation and submission of recommendations to federal, territorial, provincial, or municipal regulators for the issuance of a remediation regulatory instrument or equivalent certification defined according to the laws and regulations of the applicable jurisdiction.

The remediation process is multi-disciplinary and is usually carried out by a project team that often involves other professionals and disciplines at certain stages. This does not negate the role or responsibilities of the engineer, but does require consideration of the complementary skills and knowledge that may be required for certain sites and/or stages in the remediation work. The competencies described are those of a project team and are met by the sum of the skills of the individual practitioners, as generally one practitioner will not have all of the necessary skills.

The application of professional judgment is an integral part of doing site remediation work, and as such, the application of this national guideline and any engineering regulator practice guideline or standard may vary according to the circumstances. This is a national guideline and as such does not replace any existing legislation or revisions thereto, regulations, policies, or guidelines that exist through the engineering regulators or federal, territorial, provincial, or municipal government legislators, or preclude the need for appropriate education, training, and experience.

This document provides a common framework for engineering regulators to develop their own practice standards and guidelines to assist their licensed engineers. It provides a mechanism to evaluate the level of professional practice and quality of this work.

If an engineering regulator decides to adopt the national guideline or develop its own practice guidance or standard, a careful review of legislation and regulations should occur to ensure the national and engineering regulator-level documents do not contradict one another.

This document *does not cover site assessment* activities that investigate and define initial site conditions for the purpose of site remediation. It is assumed that the site assessment has been completed to whatever level of detail that has been prescribed or required, and that this information is fully available for planning the site remediation work.

Other aspects of contaminated site cleanup and management, which are often multi-disciplinary and involve other non-engineering disciplines, are not within the scope of this document. Engineering regulators may wish to include other topics in their own version of this document or publish separate guidelines on site investigation as well as provide more detailed guidance on remediation and risk assessment.

This document does not include activities related to site remediation that may include the recovery or extension of lands. Remediation may extend to include the removal of equipment or buildings or other structures or appurtenances, the decontamination of buildings, other structures or other appurtenances, and/or land or water; and/or the stabilization, contouring, maintenance, conditioning, or reconstruction of the surface of land and/or any other procedure, operation, or requirement specified in government regulations.

The list of recommended definitions used in this document, as well as for the use of engineering regulators preparing their own versions, is provided in Appendix A. Where such definitions conflict or differ from what is in federal, territorial, provincial, or municipal government legislation/regulations, the government regulatory definition should replace the one used in this guideline.

Engineers involved in site remediation need to address their professional and ethical responsibilities related to engineering design and project management. The responsibilities of engineers generally involve the completion and/or review of reports and plans that pertain to the planning, execution, and auditing of site remediation work that normally follows completion of a site assessment. The services also include the preparation and submission of recommendations to federal, territorial, provincial, or municipal government regulators for the issuance of a remediation certificate or equivalent certification depending on the laws and regulations of the applicable jurisdiction.

3. Guiding principles for site remediation work

There are fundamental principles that engineers must take into consideration when conducting remediation work to provide a reasonable standard of care for the public and protect the environment. The following sections identify and briefly describe these principles.

3.1 Licensing

Engineers must be licensed in all jurisdictions where providing engineering services.

3.2 Serving the public interest

In all the work that they do, engineers are bound by their Code of Ethics to safeguard the public interest, which includes life, health, property, risk of economic loss, and the environment.

Engineers recognize that stewardship of the environment is a responsibility of all citizens, taking into consideration the social aspects of developing solutions. The public expects and has a rightful role in the establishment of environmental, social, and economic sustainability goals, even though public expectations are evolving and vary widely. Engineers must remember to hold paramount the public interest, which must take precedence over all other considerations.

3.3 Serving the client's interest

Engineers must strike a proper balance between maintaining objectivity, credibility, and the trust of the public, and advocating for the client. In some cases, the client and owner are the same, but in other situations they may be separate, and this must be considered in planning site remediation.

3.4 Limits of competence

As required under the Code of Ethics, an engineer must only undertake work for which he/she is competent and qualified. The client or owner or company may assume that a licensed engineer has all the requisite expertise to perform or supervise all the elements of remediation work. The engineer is obligated to inform them of the limits of his/her competence prior to engagement in such work.

The engineer should be open to peer support and consultation, seeking a "second opinion" or peer review by other qualified practitioners as warranted by the project complexity or novel circumstances.

3.5 Maintaining specialized technical knowledge and skills

Engineers should ensure they possess the necessary education, skill, experience, and training to provide technically sound remediation work. They must ensure that their skills are consistent and current with evolving standards and technology requirements of the industry and that these skills are continuously improved and enhanced through training and knowledge sharing. The core knowledge and skills include but are not limited to:

- » Knowledge of the federal, territorial, provincial, and municipal government legislation, regulations and guidelines, or approval-specific requirements that apply to remediation in the jurisdiction(s) where the work is being carried out.
- » Knowledge and experience with preparing a remediation plan in terms of defining outcomes, identifying and responding to stakeholder concerns, managing emissions, defining the sequence of appropriate remediation activities, and establishing confirmatory requirements and monitoring program protocols.
- » Knowledge of information sources relevant to the site that could affect remediation success.
- » Ability to read and understand survey and map information, and interpret site assessment information.
- » Knowledge of, and experience with, investigation and sampling methods used to carry out the site assessments that form the basis for remediation planning, design, and implementation, as well as confirmation sampling associated with addressing site closure and any necessary post-remediation monitoring.
- » Knowledge and experience with the fate of contaminants in soil, sediment, water, biota, and air.
- » Knowledge of physical, biophysical, geotechnical, geochemical, chemical, and biological processes and their interactions.
- » Knowledge and experience with the application of current alternative remediation strategies, methods, protocols, technologies, and processes; and cost-effectiveness of technologies, for specific applications; and the ability to select appropriate and sustainable methods for environmental conditions and intended end-land use.
- » Ability to assess the suitability and sustainability of remediation technologies, taking into consideration such factors as legislative requirements and authorizations, emissions, waste management, timeframe, cost, off-site impacts, and effectiveness.
- » Understanding of sampling and laboratory procedures, analytical limitations, and statistical methods that may affect data interpretation.
- » Team skills (including project management, shared goals, team make-up, team operations, shared knowledge of accountability, and limitations of other team members, and trust).
- » Awareness of the role and contributions of engineering, geoscience, and other disciplines required to assess and remediate a site.
- » Ability to identify when additional specialized knowledge (not already included in the project team) is required.

- » Appropriate safety training and its application to protect project members and the public.
- » Communication skills (ability to communicate with the landowner/occupant, client, government regulator, and public).
- » Ability to keep records to maintain accountability for sign-off processes.
- » Ability to prepare reports and documents as necessary and review them for accuracy, clarity and completeness.
- » Ability to revise the conclusions should new information or data suggest such a need.

Detailed lists of technical competencies are available from some engineering regulators that specify the required knowledge and skills to enable the engineer to self-assess his/her skills and knowledge. These lists serve to remind engineers practising in the field of the limits of their competence and the need to practise within those limits, and assist in identifying gaps in knowledge and additional training requirements to maintain and enhance competencies.

Such measures assure the public of the quality and standard of remediation work that is performed by suitably competent engineers.

The engineer must have the skills and background to develop and substantiate engineering decisions related to planning and execution of site remediation work. Engineers, by their particular knowledge, skills and experience, may be held to a higher standard as compared with other professionals, para-professionals, technical, and administrative staff practising in the remediation field, and often fulfil the role of site professional or coordinating engineer.

3.6 Using appropriate technical expertise

Remediation projects are often multi-disciplinary and generally carried out by a project team. Some contaminated sites will require specialized approaches to reduce the potential risk to human and ecological health to acceptable levels, and it is essential that the site professional or coordinating engineer is able to recognize when specialized technical expertise is required. These situations may involve unique biophysical, chemical, geotechnical, or hydrologic circumstances. All reasonable steps shall be taken to ensure that the remediation team comprises persons with the necessary expertise, and that this expertise is appropriately applied.

Other professionals (e.g., professional geoscientists, senior environmental technologists, and environmental scientists) may undertake components of the remediation work. These individuals should be selected on the basis of their expertise and experience to undertake this type of work, and in the context of their contribution to the project.

3.7 Due diligence and reasonable care

The site remediation process, from the review of site assessment information to site closure, requires attention to detail and execution of due diligence and reasonable care.

Due diligence may be considered as the diligence reasonably expected from, and ordinarily exercised by, a person who seeks to satisfy a legal requirement or to discharge an obligation.

For site remediation, due diligence includes reviewing available information on the site including site assessment reports, databases, and government records, as required. It also includes reviewing the competencies of contractors since they will be hired to execute much of the remediation work.

Reasonable care is a test of liability for (both civil and criminal) negligence and the degree of care that a prudent and competent person engaged in the same line of business or endeavour would exercise under similar circumstances.

3.8 Increasing complexity and specialization

Site remediation work involves the design and execution of many steps, which may involve complex processes and procedures and the ever-present need for engineering judgments for a variety of stages and situations. The complexity and scope of site remediation usually requires the work to be divided into smaller segments and assigned to various employees and contractors. This complexity requires the engineer to uniquely evaluate every situation based on several factors that include:

- » Level and quality of the site assessment information.
- » Former, current, and intended future uses for the site.
- » Site conditions that include, but are not restricted to, the geology, hydrogeology, hydrology climate, soil conditions, type(s) and fate and transport of contaminant, existing buildings and structures etc., current and future land uses, and ecological constraints.
- » Available budget, schedule, and human resources.
- » Availability and costs of appropriate technologies and remediation techniques.
- » Overall environmental, social, and economic project costs to society.

- » Jurisdictional considerations (i.e., which regulations and standards apply to the site).
- » Applicable permitting processes, approval requirements, and compliance issues.
- » Liability considerations.
- » Who the client is (landowner, buyer or company), what their objectives are, and potential conflicts of interest between interested parties.

Risk-based approaches to site remediation are accepted practice in many but not all jurisdictions. Innovative and cost-effective risk assessment/risk management approaches to site remediation are being implemented in some jurisdictions and are gaining wider acceptance in the industry and recognition by government regulators.

3.9 Knowledge of and compliance with government regulatory requirements

Engineers involved in site remediation have a professional responsibility and obligation to be familiar with federal, territorial, provincial, and municipal government legislation, regulations, policies, and guidelines that apply to their particular discipline or area of expertise within the jurisdiction in which the work will be completed. Permitting processes, approval requirements, and compliance issues will vary depending on the site location and the remediation technology employed.

Government regulatory requirements include compliance with municipal bylaws, provincial/territorial acts and regulations, and federal laws and regulations that are applicable to the site. The engineer should be aware of the applicable acts, regulations, and by-laws from all levels of government.

Federal, territorial, provincial, and municipal government regulatory frameworks that govern site remediation in their respective jurisdictions are subject to periodic review and change to accommodate new scientific knowledge, advances in technologies, and standards and processes, as well as establish new and variable site contaminant criteria conditions and associated environmental impacts. It is incumbent upon the engineer to review and keep up-to-date with regulatory revisions and changes that are applicable for the jurisdictions in which they are performing site remediation.

Compliance will vary according to the site conditions, type of contaminant, and the standards related to the use or zoning of the land.

3.10 Accountability to multiple stakeholders

Engineers are accountable to many different stakeholders in site remediation work, including:

- » The employer/client/land-owner, through the employment and project contracts
- » The public, through public input
- » The courts, on issues of safety, liability, and duty of care
- » Themselves and the engineering profession, by adhering to the Code of Ethics
- » First Nations interests, as applicable to the site
- » The government regulator, who has power of enforcement of legislation and regulations

Further, as professionals, engineers' actions may be influenced by insurers through terms of insurance policies, even though there may be no direct accountability to insurers.

Of these many stakeholders, the relationship that the engineer has with the client or employer is especially influential on technical autonomy and work context. In the client-professional relationship, the engineer is generally autonomous in choosing which clients to serve, when, how, what to charge, etc. But in the employer-professional relationship, the engineer's autonomy may decrease.

Employers prefer to control when, to whom, and under what conditions the employees provide services. Employers also judge the performance of employees and strongly influence standards, ethics, and competencies that may affect a professional employee's ability to maintain highly professional behaviour. Thus, some of the characteristics that identify a professional – autonomy, commitment, identification, and ethics – may be influenced where the professional answers directly to the employer and less frequently to the client and professional association. Whether engineers are employers, supervisors, clients, or employees, there may be competing or contradictory demands to be considered. Provincial/territorial guidelines on ethical practice should be consulted when considering the various stakeholders and their demands.

4. Site remediation process and authentication of results

4.1 Site assessment information

Although this guideline assumes that a Phase I and follow-on Phase II Site Assessment (or other applicable site investigation terms and approaches under the relevant government regulatory regime) has been completed to the standard

required by the applicable provincial or territorial legislation, and has been made available, it is still the obligation of the engineer planning site remediation to review the assessment reports and information to satisfy themselves that the available data are sufficient to design and execute the site remediation program.

Proper site assessment characterization is critical for setting remediation targets. There may be an inconsistency in the level of work undertaken for site assessment versus that required for site remediation. This may be resolved by reviewing the quality of the data and clarifying the level of responsibility between the client, site assessment contractor, government regulator reviewer, site remediation contractor, and the final approval of the work by the government regulator as part of the remediation action plan that is described below. Such clarification should be undertaken at the initial stage of the remediation planning process, particularly if the engineer was not directly involved in the site assessment work.

The site assessment and any follow-up (supplementary) site investigation(s) should provide a sufficiently complete description of local hydrogeologic and geologic conditions, and clarify the type and distribution of contaminants (lateral and vertical delineation). This information serves as the informed basis for all other activities, including developing a conceptual site model and setting remediation targets.

If the engineer believes that there is insufficient information from the site assessment, the date of the site assessment is such that there is a possibility that conditions may have significantly changed, or the quality of the data is such that it cannot be relied upon, it is his/her duty to advise the client/owner before remediation targets are finalized. Additional on-site and potentially off-site investigation will likely be required under such circumstances. The engineer must also be aware of any government regulatory requirements for the currency of data, and identify requirements to conduct additional site assessment work to corroborate the existing data set.

4.2 Setting remediation objectives

The objective of site remediation is most often to return an impacted property/site to an environmental condition that is reasonable for current or future land use in accordance with any benchmarks that are provided in government legislative or regulatory requirements.

Alternatively, the objective may be to secure the site to mitigate or prevent future adverse impacts, address off-site issues associated with migration of contamination to neighboring properties, or reduce human health and ecological risks to acceptable levels.

Before remediation objectives are set, the engineer should confirm the client's intentions for the site. Often there are different remediation objectives for the property/site depending on the current and future use(s) of the site and current zoning by-laws. For example, the objectives may range from preparing the site for sale, to modifying it for a new use, to compliance with an environmental order. There are three common objectives that can be used to determine targets for site remediation:

1. Remediation to restore the site or property to an environmental condition consistent with ambient or background conditions
2. Remediation to comply with established criteria
3. Remediation to comply with criteria established through site-specific risk assessment techniques

With the obligation to serve the public interest and Code of Ethics of paramount importance, the engineer should consider, at minimum, the following factors when setting site-specific objectives:

- » Current and future land use
- » Federal, Provincial, Territorial, and Municipal government regulatory requirements
- » Remediation targets
- » Remediation timeframe
- » Availability, appropriateness, and cost of remediation technologies
- » Potential off-site impacts on a regional and global scale, such as greenhouse gas generation, water pollution, and consumption of natural resources
- » Potential off-site impacts on a local scale, such as traffic, noise, and air quality
- » Potential or existing off-site migration of contaminants and the impact on the current use of off-site properties that are affected
- » Budget constraints
- » Sustainability of remediation techniques
- » Client or owner risk tolerance

4.3 Setting remediation targets

Compatible remediation targets are also influenced by:

- » Federal, Provincial, Territorial, and Municipal government regulatory requirements
- » Public interests, including First Nations
- » Valid ecological concerns
- » Sustainability considerations
- » Corporate objectives and policies

Setting remediation targets includes consideration for remediation criteria that are typically produced and enforced by federal, provincial, and territorial governments. Many provinces and territories have established remediation criteria that are intended to protect human health and/or the environment. Such criteria are typically developed for media such as soil, soil vapour, groundwater, surface water, air, and sediment. The engineer needs to be aware of criteria established by government regulatory jurisdictions, which are typically available through provincial/territorial websites, as well as the limitations of these criteria, to apprise the client of a criteria-based approach to site remediation.

A risk and receptor evaluation should be carried out to determine those portions of the site (or environmental media) that:

- » Meet generic government regulatory guidelines and criteria
- » Warrant the establishment of site-specific objectives (ecological and human health risk assessment)
- » Require remediation
- » Require ongoing monitoring and/or risk management

There may be situations where only partial remediation of a site is possible or being undertaken. It may be difficult to obtain a remediation certificate from the government regulator for such projects, which may prohibit a professional sign-off or other site certification mechanism (instrument) that is applicable. An example would be an interim or partial remediation with full remediation to be conducted at a later date. In such cases, the engineer may be required to sign-off on the project to indicate that the partial

remediation is complete to the initially approved scope of work. The engineer signing off on the project should clearly identify any impacted areas not addressed in the project through a letter or report that accompanies such a sign-off.

For larger sites with multiple legal lots, depending on the nature of contamination and whether off-site migration has occurred, or has the potential to occur, it may be possible to obtain an instrument from the government regulator for individual legal lots. Using such an approach may be subject to completing the remediation and preparing the remediation report, and with any necessary post-remediation monitoring in place.

In certain circumstances, the established criteria-based approach may not be suitable for a site (e.g., pathways of exposure, target chemicals or other contaminants, receptors or other site characteristics differ from those used to set the criteria) and risk assessment procedures may be required to set objectives and remediation targets.

Setting attainable remediation targets based on site-specific risk assessment may be used to optimize site remediation for a site, based on the particular conditions present at that site. Risk assessment, either qualitative or quantitative, can be used to define the ultimate implications of the impact. Many types of risk often apply at least conceptually (i.e., human health, ecological, economic, public relations, personal, and corporate liability). Assessing risks can help determine when conditions need to be improved, so that risks can be reduced, remediation objectives that correspond to a certain level of risk can be set, and clean-up priorities based on risk estimates can be assigned.

Each risk assessment has the potential to pose numerous challenges since these are often complex exercises involving numerous combinations of receptors, pathways, and chemicals or other contaminants. Limitations in the available data require assumptions to be made and supported, and/or additional investigations or studies to be undertaken to fill data gaps. Communicating the results of a risk assessment in the context of setting remediation targets warrants special care since experience has shown that risk-related concepts without any source removal within accessible and highly contaminated areas are difficult to communicate, especially to the public.

The overall result is that the coordinating engineer managing a risk assessment project should have the necessary experience and background. This includes a sound understanding of the risk assessment process and associated government regulatory processes, familiarity with the various disciplines that are part of the risk assessment, the ability to coordinate the work of specialists, an appreciation of the inherent limitations of risk assessment, and good communication skills.

The coordinating engineer may be required to sign documents or affidavits that characterize the site and the findings of the risk assessment, or summarize the risk management measures to be taken.

4.4 Identification and evaluation of remediation alternatives

Once remediation objectives and targets are established, the next step is to identify and select site remediation alternatives

for detailed review and consideration. Remediation activities may involve excavation and landfill disposal operations, the complete elimination or destruction of identified hazardous materials, in-situ or ex-situ reductions of concentrations to meet remediation criteria (either background, government regulatory, or risk-based), prevention of exposure to hazardous materials through engineering or institutional controls, or some combination of the above.

Bench-scale and pilot-scale testing of remediation technologies can be a critical, but not necessary, step in the evaluation of remediation options. Each site is unique, and it may be prudent to test alternative treatment technologies on bench scale testing and/or a small pilot-scale test before committing the potentially substantial financial resources for full-scale implementation.

Remediation alternatives are evaluated and compared using technical and economic analyses. These may include the application of technologies and the media to which they apply. Cost-effective alternatives capable of achieving the remediation goals are selected for evaluation through treatability studies and, if necessary, pilot-scale implementation. The value of conducting these studies and pilot tests must be weighed against the available budget and time required. If significant cost savings can be achieved, or if uncertainties can be reduced to tolerable levels, then treatability studies would be warranted. On sites requiring immediate action due to unacceptable risk, remediation technologies that require pilot-scale testing are not likely to be feasible given the timelines required to design, undertake, and evaluate such programs.

Where there is only one method that is technically feasible or obvious, the engineer may proceed directly to the next step, which is normally the preparation of a remediation action plan.

4.5 Remediation action plan

Once a remediation method is selected, a remediation action plan (RAP) is prepared that provides a description of the project to the preliminary design stage, defines the desired outcomes and appropriate remediation requirements; describes the plans and defines the sequence of activities for implementing the selected remediation alternative that responds to stakeholder concerns; identifies approaches to mitigate the off-site effects of the remediation program; and establishes monitoring and confirmatory requirements.

The RAP also serves as the basis for discussing implementation of the remediation work with the client, owner, government regulatory authorities, and/or other stakeholders. In some jurisdictions, there is a requirement to submit the RAP to a government regulatory authority for approval prior to commencing the remediation work.

The RAP normally includes the following elements:

- » Description of objectives and remediation targets, including any specific remediation criteria to be achieved.
- » Overview of the site contamination and site conditions affecting remediation, including soil and stratigraphy, soil vapour, surface water, groundwater, and aquifers.
- » Description of the media/materials to be remediated.
- » Description of the management of potential excess soils and groundwater (e.g. movement, disposal, quantities, etc.) during remediation from source site to receiving sites in compliance with local guidelines.
- » Description of the stakeholder concerns.
- » Description and review of options that appear to be best suited to remediate specific conditions.
- » Description of the remediation strategy and the sequence of activities for remediation, including specific reference to each area to be remediated in terms of lateral and vertical extents, overall surface area, and overall volume, as well as volumes to be remediated with respect to each class of contamination (typically based on soil or sediment standards).
- » Identification of requirements for appropriate specialists.
- » Description of risk management plans (see below).
- » Description of the issue resolution process.
- » Descriptions of types of pilot-scale tests to confirm the viability of specific options, including treatment equipment, if any.
- » Estimates of time and cost to initiate and complete remediation.
- » Description of government regulatory approval requirements.
- » Description of the public communications plan.
- » Construction plans.
- » Design and specification of remediation work.
- » Description of methods to manage accumulated water, dust, noise, and traffic.
- » Requirements for environmental/emission monitoring.

- » Descriptions of monitoring and confirmatory sampling plans.
- » Requirements for a site-specific health and safety plan.
- » Descriptions of contingency plans.
- » Identification of the fate of residual contaminants.
- » Descriptions of remediation verification and long-term monitoring plans.
- » Descriptions of mobilization and site preparation.
- » Descriptions of materials handling.
- » Descriptions of the management of by-products.
- » Project schedule/duration.
- » Site restoration and closure process.
- » Reporting/documentation requirements.
- » Closure and sign-off.
- » Key contact information.

In cases where risk assessment becomes part of the remedial approach for a site, risk management plans are a best practice in all jurisdictions, although not necessary in all circumstances. Local regulations should be consulted on situations that require this work. Risk assessment may be a subset of the remedial action plan or prepared as a separate document. The responsibilities and guiding principles for the engineer preparing such a plan are the same in either case.

The importance of contingency planning for site remediation cannot be overemphasized. There are many occasions where additional information not previously identified or obtained during the site assessment process is discovered during a site remediation activity, especially where excavation is part of the remedial activity. Potential questions that should be contemplated during the preparation of the plan would include:

- » What is the level of confidence that the areas to be remediated have been sufficiently delineated vertically and laterally in regard to risks associated with confirmatory sampling identifying residual contamination along the inferred limit of excavation?
- » How would discoveries of previously unknown infrastructure, such as underground storage tanks, be handled?
- » How would discoveries of potential off-site impacts be handled?
- » Would they be different for private, federal, provincial/territorial, or municipal property?
- » Is the client or owner aware of these potential items and are provisions in place to deal with them as they occur, or would these discoveries halt any remedial project until a completely new remediation action plan could be developed and approved based on the new information?

Reference to other potential contingencies in the plan may be useful in alleviating project delays or confusion e.g., unexpected water inflows, previously unidentified or abandoned utilities, additional underground storage tanks, etc.

Detailed construction/remediation drawings are typically developed at this stage and are used to solicit bids for implementing the project and potentially for government regulatory approvals. The plan may include applying for permits and approvals for decommissioning or demolition of building structures and/or equipment in addition to the remediation of solid, liquid, or gaseous matrices.

4.6 Implementation of remediation action plan

Considerations involved in executing the Remediation Action Plan (RAP) include:

1. Preparation of Specifications and Tender Documents, Contractor Selection
2. On-site supervision
3. Alternate project delivery

In many cases, engineers still act as the owner's engineer, with the owner entering into a separate contract with the contractor(s) carrying out the work.

On-site supervision is usually essential during remediation operations to confirm that the client's interests are addressed and that the contractor is executing the RAP as specified in the contract, as well as to develop remediation verification information (e.g., through confirmatory sampling and testing). Periodic progress checks should be undertaken to ascertain if objectives and remediation targets are being met. If activities deviate from the RAP or objectives and targets are not achieved, the engineer should advise the client or owner. Further corrective actions should be documented.

Alternative project delivery methods may result in changes to the role of the engineer, which may include project financing, design/build and turnkey delivery, contract operations, or own/construct/operate.

Full integration of the technical and project management functions can assist with implementing a remediation program efficiently and successfully.

4.7 Verification and documentation

Verification sampling of the remediated areas/materials must be undertaken to confirm the results to ensure the remediation plan has been followed and the remediation activities have been effective. Thorough documentation, including verification data and written and photographic records of remediation activities, is necessary to demonstrate that the objectives and remediation criteria have been met. Verification of remedial works is necessary to satisfy government regulatory requirements to obtain regulatory instrument(s).

Registering remediated site conditions on land title may be required to document the nature of the remediation and any residual contamination. Other jurisdictional requirements are likely and the engineer should be aware of local requirements and the need to fulfill them. Documentation prepared by the engineer is likely to form the basis for developing this registration.

4.8 Authentication

An engineer must authenticate the originals of all site remediation documents he/she has prepared in part or in whole. He/she does so by affixing his/her seal, signature, and date on the plans and specifications and other engineering documents that must be authenticated by law, citing his/her professional designation.

The process and details of the authentication process are within the purview of engineering regulators. The engineer is governed by the procedures of the engineering regulator in the location where site remediation is performed.

For site remediation work involving several engineering disciplines, all documents within a particular engineering discipline should be sealed and signed by the engineer taking overall responsibility for work within that discipline. Because of the multi-disciplinary nature of site remediation projects, other professionals involved in the site remediation program (e.g., professional geoscientists, professional biologists, etc.) may also have an obligation to sign and seal the document. It is important that the coordinating engineer identifies the need for other professionals to sign and seal the document, and confirms their understanding of this requirement as part of their engagement.

The coordinating engineer (if there is one) should also apply his/her seal to indicate that the work of the various disciplines has been coordinated. If only one signature and seal is used, it should be that of the engineer taking responsibility for the work, generally the coordinating engineer. Engineers applying their seal/stamp and signature should qualify their level of responsibility (i.e., what discipline they are taking responsibility for).

Authentication should not be jeopardized for commercial reasons; failure to recognize this compromises public health and safety, the reputation of the engineer, and the work itself.

In authenticating documents related to site remediation such as the RAP, engineers are confirming that:

- » The documentation was prepared by themselves or it was prepared under their direct supervision, or they have completed a thorough arms-length review and can accept professional responsibility for the work therein.
- » They have the relevant training, experience, and working knowledge of legislation, regulation, and guidelines relevant to the topic.
- » They have knowledge of relevant information sources.
- » They are competent to do the work or to directly supervise the work contained therein, or competent to do an arms-length review of work prepared by another engineer, professional, or para-professional.
- » They are functioning under the standards and terms of their profession.
- » Government regulators, other professionals, and the public may rely upon the work.

4.9 Ongoing supervision and monitoring

Long-term monitoring may be required to address residual impacts that may not have been addressed through an active remediation strategy. It may also be a condition to demonstrate that remedial objectives have reached government regulatory or risk-based standards and will remain so in the long-term. However, long-term or ongoing monitoring may not be appropriate for all sites.

Monitoring should be completed such that a sufficient amount of information is gathered on a regular basis to ensure that the mitigative measures taken ensure that an unacceptable level of ongoing risk does not remain.

4.10 Site closure

Most jurisdictions have an official site closure process that follows the completion of all remediation work and verification that

the objectives and remediation criteria have been met.

The coordinating engineer should be aware of any jurisdictional requirements concerning the submission of a letter or closure report that the site has been remediated to an established standard of use and execute accordingly.

In such cases, the coordinating engineer would normally submit a letter or closure report that certifies that the site has been remediated to an established standard of use (i.e., to meet zoning by-laws or some other form of pre-established level through mutual agreement). The government regulator would conclude the process by issuing a statutory instrument or letter advising that no further remediation is required.

5. Responsibilities of the parties involved

5.1 Responsibilities of the client

In order for engineers to carry out remediation, the client should undertake the following:

- » Identify and, if necessary, screen through a prequalifying process appropriately qualified engineering firms with appropriate geo-environmental capabilities. While financial considerations play a role in such an evaluation, the evaluation should place a greater emphasis on technical capabilities of the consultants and their ability to deliver projects.
- » Work with the coordinating engineer to define the scope of work and deliverables, ensuring that the scope of the site assessment adequately identifies all potential contaminants of environmental concern.
- » Clarify the roles and responsibilities of the various professionals, para-professionals, and remediation contractors engaged by the client in the remediation work.
- » Complete a written agreement with the coordinating engineer confirming the scope, assumptions, compensation, and schedule of services, before work starts.
- » Disclose fully and promptly to the engaged coordinating engineer all information (written or otherwise) related to prior site uses (e.g., operational history of the site), and site assessment(s) that have been completed.
- » Disclose promptly to the coordinating engineer all previous involvement by other professionals performing remediation on the site, including site assessments related to the operational life of the site, and any actual or potential conflicts.
- » Recognize the potential need for clarification or additional work associated with the reports, plans, and assessments submitted for review, before the engineer can authenticate these or other documents.
- » Ensure that all appropriate documents are submitted to the government regulator(s). If there are any outstanding issues, the client should discuss these with the coordinating engineer before the application is submitted to the government regulator(s).
- » Grant or arrange for the engineer and others associated with the remediation activities being conducted by the engineer to have unimpeded access to the site.

5.2 Responsibilities of the government regulators

Government regulators have specific responsibilities under federal and territorial/provincial legislation to administer site remediation regulations, and may be expected to undertake the following:

- » Respond promptly, in writing, to questions submitted in writing by the engineer concerning interpretation of acts, regulations, policy, procedures, and guidance that may arise during the work.
- » Provide assurance to the public that the system of professional regulation is operating to an acceptable standard.
- » Ensure that the appropriate policies and regulations are in place to guide engineers in their work.
- » Engage the appropriate engineers and geoscientists in the development and implementation of policies and regulations related to remediation.
- » Process site remediation reports and issue statutory instruments/letters of closure.

The first step undertaken for government regulators receiving a site remediation report consists of checking to satisfy themselves that the application is complete and administratively compliant. If the report is incomplete, it is normally returned without any review.

Upon receiving a complete and compliant remediation report, the government regulator may often complete one of two types of review:

- » **Technical Review:** to determine if the site documentation demonstrates the specified remediated site is compliant with legislation, criteria, guidelines and policy.

» **Audit Review:** to determine compliance with legislation, criteria, guidelines, and policy.

The coordinating engineer should have early and continuing dialogue with the government regulator through all the steps of planning, approving, executing, and verifying site remediation.

5.3 Responsibilities of the engineering regulators

Regulators for the practice of engineering in their respective jurisdictions have several responsibilities in regulating the engineering elements of site remediation work. These include developing practice standards and guidelines, defining and administering the Code of Ethics, and investigating complaints and disciplining engineers if standards for remediation work or ethics have been breached.

In addition, each engineering regulator promotes and, in some cases, maintains records of continuing professional development of engineers, including ongoing continuing professional development programs.

5.4 Responsibilities of the engineer

The engineer, regardless of his or her role in the scope of site remediation work, has the primary duty to protect the public and environment, as well as a duty to conduct all work to an appropriate standard of care.

The engineer should determine if he or she has a potential or perceived conflict of interest in conducting site remediation work before establishing an agreement for services. If the performance of work can reasonably be foreseen to result in a conflict of interest, the engineer should not conduct the work. If there is a potential or perceived conflict of interest at any time before or during performance of the work, the engineer should document and inform all involved parties of the conflict.

The coordinating engineer needs to interact with the applicable government regulator and stakeholders early in the planning stages of a remediation project, and throughout and following the actual remediation.

The engineer needs to maintain a current knowledge of all acts, regulations, policies, procedures, and guidance documents of the appropriate regulators and of other agencies (whether at the municipal, provincial, or federal government level) in the province or territory where he/she performs site remediation work, and must also know whether federal jurisdiction may apply. The engineer should ensure that all aspects of the relevant environmental legislation have been followed.

The engineer should maintain a current knowledge of science, engineering, and standard industry practice related to remediation. Using this knowledge, the engineer must determine the technical disciplines required to address the project objectives and assemble the appropriately qualified team members.

If, during his or her review, the engineer becomes aware of a poor or prohibited practice, he/she should promptly bring this to the attention of the responsible party and/or client, (including the responsible engineer) and, where appropriate, the government regulator, and/or the engineering regulator.

The engineer may be required to rely on reports, plans, assessments, or other documents prepared by others. The engineer should make reasonable efforts to confirm that the data have been collected in a manner consistent with professional practice and that no unintentional bias exists in the data. The engineer should highlight to the client any issues associated with the quality of previous site assessment(s) conducted by others and whether previous data provided by the client can be relied upon.

The engineer is responsible for documenting the remediation work or seeing that it is documented properly. He/she should ensure that all acts, regulations, policy, procedures, and guidance are followed and that documentation of site remediation activities is accurate, consistent, and complete.

If the engineer encounters aspects of site remediation that differ from the government regulators' policy and guidance, but in his or her judgment the work conforms with the intent of the act and regulations, the engineer may, in certain cases, seek written clarification from the appropriate government regulator prior to submitting site remediation documentation (e.g. a regulatory instrument application).

5.5 Multi-disciplinary team structure and management

The organization of remediation work varies according to the needs of the project and the parties involved. These relationships may be structured in several configurations, depending upon the expertise of the client/owner, the complexity of the remediation work to be performed, and the contractual arrangements.

The team of professionals that needs to be assembled to provide the appropriate knowledge and experience may be categorized into four groups:

5.5.1. Coordinating engineer

The coordinating engineer should have appropriate qualifications and experience to undertake the defined scope of

remediation work. Capabilities should include the ability to provide overall professional services, including design, contract administration, and field review for the total project.

If the client, owner, or company selects a coordinating engineer from in-house staff, the selected engineer should identify and disclose any conflict of interest. In some jurisdictions, the engineer responsible for filing documentation to support the issuance of a regulatory instrument to confirm the site remediation cannot be employed by the owner of the property.

5.5.2. Contributing engineer

Contributing engineers are selected based on the technical needs of the remediation project. Selection may be by the coordinating engineer or the client/owner, based on the scope of work and complexity of the remediation work and the evaluation of contributing engineers' competence and capacity to undertake the assignment. Contributing engineers must be registered in the jurisdiction where the site remediation work is to take place.

The work of contributing engineers should be identified and documented in all applicable reports. The sign-off documentation of contributing engineers should be maintained in the project file.

5.5.3. Other professionals

Individuals with specialized geotechnical, natural science, land-use planning expertise, or other professional disciplines, are sometimes required. Such individuals may or may not be registered with a professional regulatory organization. The work of other professionals should be identified, and the sign-off documentation, as applicable, should be maintained in the project file.

The coordinating or contributing engineer should select other professionals based on knowledge, experience, and record on past projects, and check on any professional qualifications, if available and applicable.

5.5.4. Competent practitioners

Individuals who are not registered as a professional member in a professional regulatory organization may complete components of the work. The engineer who engages the competent practitioner must accept responsibility for the work completed by that practitioner.

5.6 Responsibilities of the coordinating engineer

The coordinating engineer is normally responsible for all aspects of site remediation, including assessment information review, remediation methodology and technology selection, planning/design, coordination, field reviews, site plans, quality assurance/quality control (QA/QC), reporting, and verification. The work of the coordinating engineer may include the review and assurance of work conducted by project team members under his or her direct supervision, or a review of the work conducted by others, or a combination thereof.

Responsibilities of the coordinating engineer, whether carried out directly by the coordinating engineer or others, include but are not limited to the following:

- » Confirming the overall quality of field sampling and analytical data collected, that the QA/QC program meets standards, and that the analytical data support the conclusions regarding field conditions.
- » Reviewing investigations, plans, assessments, reports, and other documents that report on the site condition, determining if these materials support the conclusions regarding the compliance of the site with applicable guidelines and standards, and ensuring that these documents are submitted along with the application for regulatory approvals if required in the jurisdiction (e.g., a regulatory instrument, such as a remediation certificate). The final accountability to the public and regulators lies with the coordinating engineer authenticating the application.
- » Bringing deficiencies in previous or current work, or circumstances that may pose unacceptable risk to the public to the attention of the client, in writing.
- » Selecting appropriate remediation objectives and target criteria, preparing RAP(s), and selecting remediation work and technologies, or reviewing such work prepared by others.
- » Overseeing site remediation activities, planning and executing verification measures, preparing documentation, and verifying appropriate authentication procedures have been followed.
- » Applying professional and responsible judgment in interpreting the work of contributing engineers and other team members.

When acting as the project manager, the coordinating engineer should develop, implement, and maintain a suitable team structure and management plan to ensure that the work and the associated responsibilities are distributed appropriately.

A coordinating engineer cannot take responsibility for work outside of his or her scope of practice. The coordinating engineer must rely on the appropriate contributing engineer(s) and other professionals and team members. However, the coordinating engineer should be familiar enough with the work carried out by contributing team members to be able to identify when specialist contributions are required and be able to review the work produced from at least a qualitative

perspective.

5.7 Responsibilities of the contributing engineer

The contributing engineer is responsible for conducting or preparing a portion of the site remediation work as delegated by the coordinating engineer. This could be an area of specialist expertise or a portion of the site remediation work of a non-specialized nature.

A contributing engineer retained for specialized skills should accept responsibility for conducting work in that specialization to a professional standard of practice and care, and should be vigilant in selecting a remediation process or assembling a team to apply sufficient and appropriate knowledge and experience.

6. Quality and risk management

The management of quality and risk in undertaking site remediation work and applying for the appropriate regulatory approvals and sign-offs should be considered in every project.

6.1 Liabilities, risks, and responsibilities

Liability risks can be controlled through an adequate quality management program that includes organizational and operational elements. All major risks and liabilities should be identified and documented.

A risk register is an example of how to document risks. It should include the probability of occurrence and consequences, which allows a risk designation to be allocated to each risk as well as which party (client, engineer, contractor) should be assigned the risk. It should then allocate mitigation measures and contingencies for each risk item. It is preferable that this process is conducted collaboratively with the client. The risk register should be maintained throughout the project and updated as necessary.

Important elements within a quality management program include, but are not limited to, the following:

- » Well-developed objectives, scope, schedule, and budget;
- » A process for scope changes and developing agreed-to progress milestones.
- » Clear definition of responsibilities of all project participants.
- » Effective documentation and communication throughout the project.
- » Securing and assigning suitably qualified staff and contract services.
- » Having adequate professional liability insurance coverage.

Professional liability insurance is an important aspect of risk management for the owner, client, and engineer. Such policies may be part of comprehensive, project-specific insurance acquired by the client or owner, but more commonly are practice policies purchased by professional firms offering such services, or by the individual engineer, if he/she is a sole practitioner.

Engineers should be aware of professional limitations legislation in their province/territory that may apply to the situation where there is contamination found/reported by the public after approval of the remediation. Accordingly, they should ensure they have adequate professional liability insurance and/or employer/contractor/client liability insurance to address such a situation.

6.2 Quality assurance and quality control

The coordinating engineer should be aware of any QA/QC requirements established through regulations or guidelines of the jurisdiction in which the site remediation is carried out.

A QA/QC program is the foundation upon which the engineer assures the remediation work is being, or has been, adequately performed. The program should be the tool the engineer uses to make engineering decisions throughout the project and to decide that the objectives and remediation targets have been met. QA/QC is not only related to the technical aspects of the remediation work, but also its cost, schedule and performance. The program should also include a process to report progress to the client, owner, company, and, in some cases, the government regulator.

Appropriate QA/QC necessitates that the coordinating engineer leading remediation activities has acceptable education and experience relevant to the work required. In this regard, quality assurance measures that are commonly employed include:

- » Advanced education, training, and experience that prepares the engineer for the most common situations to be addressed during remediation activities, to recognize their limitations.
- » Awareness of situations that will require specialist input, and the appropriate selection of specialists for the task.

- » Access to peer support and consultation.
- » Provision for supervisor-observed competency so that learning engineers' training are directly observed by a qualified engineer who is verified as having the skills to perform the remediation task.
- » Performance audits and reviews by coordinating engineers and contributing engineers to verify whether the remediation work has been adequately performed.
- » Use of standard field tests and assessment protocols, including the use of standard analytical tests by accredited laboratories (e.g., CALA, SCC, AIHA) to ensure that test results are accurate and repeatable.
- » Government regulatory review/audit of written reports to assure that work has been adequately performed.

Some additional examples of QA/QC measures commonly employed in site remediation include:

- » Quality management standards.
- » Advanced training of practitioners and use of specialized expertise and services.
- » Peer support, peer review, technical support.
- » Task supervision and performance audits.
- » Standard field tests and assessment protocols,
- » Standard operating guidelines and procedures.
- » Documentation and detailed record keeping of field work, duplicate sampling, testing, ongoing monitoring and decommissioning, sample storage and delivery, etc.

6.3 Interpretation, assumptions, and limitations

The engineer should always work within the scope of work assigned and, if the coordinating engineer, the objectives and scope of the whole project.

In carrying out his/her portion of the site remediation work, the engineer should state any limitations and/or assumptions made in the performance of such work.

6.4 Documentation and reporting

The engineer should be aware that the client and the regulator may have different documentation and reporting requirements. Meeting regulatory requirements should always take precedence to adequately protect the public.

There is a possibility that an engineer's report may be addressed to a client's legal counsel where it may become "confidential" under a client-solicitor relationship and not in the public domain. If such a report identifies an issue or issue(s) that an engineer believes will negatively impact on the public health or safety, there is an ethical obligation to report to the appropriate government regulatory authority. In such situations, the engineer is advised to consult with their engineering regulator for guidance and documentation relating to an engineer's duty to report.

Engineers should retain copies of their documentation and reports for the limitation period established by law in the jurisdiction where the site remediation was undertaken.

6.5 Special services

Engineers may be called upon to perform special services related to site remediation, which include but are not limited to:

- » Expert testimony
- » Presentation at public meetings
- » Advisory services

Expert testimony may be required of engineers to support regulatory hearings, courts of law, inquest hearings, and discoveries before committees. The engineer should ensure such testimony is within his/her range of experience, chosen discipline, and expertise.

The purpose of expert testimony is to provide unbiased, truthful information to assist the judge, board, or jury in making a sound decision. Many engineering regulators publish a professional guideline for an engineer as an Expert Witness, which should be consulted for further guidance.

In making such presentations, the engineer should have a comprehensive understanding of the subject, and consider using a team approach for significant public processes and complex situations.

Engineers may be retained to provide advisory services to stakeholders objecting to a proposed site assessment, remediation, or management project. The work may involve verification of other work to provide an independent opinion to the client. Engineers should be particularly mindful of their professional responsibilities in reviewing another engineer's work. Several engineering regulators provide guidance for such reviews through published guidelines.

Appendix A: Definitions

The following is a list of recommended definitions for the use of engineering regulators preparing their own versions of this document as a practice guideline or for engineers using this guideline for reference. Where such definitions conflict or differ from what is in provincial or territorial legislation/regulations, the regulatory definition must replace the one used in this guideline.

“Approved professional” means an engineer who has either specialized technical expertise and responsibility, or who has managerial responsibility, for a portion of the site remediation work, and who takes responsibility for that portion of the work that can be relied upon by the site professional. This may also be referred to as the “contributing engineer” in some jurisdictions.

“Client” is the party who engages the coordinating engineer and, in some cases, the contributing engineer(s) to provide the required professional site remediation services. The client may be the owner or a potential buyer of the property, be it an individual or a company or an affected third party which could include government.

“Contaminant” means any organic or inorganic substance that, when released into the environment, may endanger the health, safety, or welfare of the public, or negatively impact the environment.

“Contamination” is generally considered to be the release of contaminants as a result of human activity that has or will exceed acceptable levels. Contamination may be present at a site due to several factors, including but not limited to the site's historical operations, the occurrence of spills, leaks or discharges, deposition of by-products or residues, cumulative effects of airborne deposition, subsurface migration or direct application or burial, or the use of imported fill.

“Due diligence” is the care that a reasonable engineer exercises under the circumstances to avoid harm to other persons, property, and the environment.

“Monitoring” is the routine sampling of water, sediment soil, or air samples at an appropriate frequency and location; the analyses of the samples for contaminants; and the collection or reporting of the methodology and interpretation of the results.

“Objective” is a numerical limit, a risk-based limit, or narrative statement that has been established for a contaminant in water, sediment, soil, or air to protect or maintain a specified use of a particular site, taking into account site-specific conditions. Objectives may be adopted directly from generic criteria or formulated to account for site-specific conditions.

“Owner” includes a lessee, a person in charge, a person who has care and control, or a person who holds his or herself as having the powers and authority of ownership, or who exercises the powers of ownership for the time being.

“Person” includes an individual, corporation, company, association, firm, partnership, society, or other entity/organization.

“Professional sign-off” is the application of a engineer's authentication to a plan, report, map, or any other form of document indicating that the engineer has supervised and/or reviewed the remediation of the property; that the property has been remediated to an acceptable standard; and that the government regulators may rely upon the engineer for reporting and issuing a remediation certificate or equivalent certification for the property.

“Project” is the total work contemplated.

“Property” comprises land, buildings, and installations, as well as the improvement of any physical object with some degree of permanence.

“Quality assurance” means evaluating overall project performance on a regular basis to provide confidence that the project will satisfy the relevant quality standards.

“Quality control” means monitoring specific project results to determine if they comply with relevant quality standards and identifying ways to eliminate causes of unsatisfactory results.

“Government regulator” is an authority having jurisdiction over remediation work at the federal, territorial, provincial, or municipal level of government.

“Remediation” means the development and application of a planned approach to treat, remove, or destroy contaminants present in the soil or groundwater within a site for the purpose of reducing their concentration or availability to acceptable levels to prevent or mitigate damage to human health, the environment, or ecological receptors of concern.

“Remediation action plan (RAP)” is a plan that identifies site-specific remedial objectives for a site, identifies remedial options and outlines their feasibility, and recommends and describes a preferred conceptual remediation plan, a

performance monitoring plan, and, if appropriate, requirements for ongoing site management.

“**Remediation criteria**” are the numerical limits, risk-based standards or criteria, or narrative statements pertaining to individual contaminants in air, water, sediment, soil, or air, which are recommended to protect and maintain the specified uses of a contaminated site.

“**Risk**” is a measure of both the severity of human health and ecological health effects arising from potential exposure to contamination and the probability of the occurrence.

“**Risk assessment**” is a scientific procedure designed to determine the qualitative aspects of hazard identification and usually includes a quantitative determination of the level of risk based on deterministic or probabilistic techniques.

“**Risk management plan**” is a document that a responsible party, such as a coordinating engineer, prepares to foresee risks, estimate impacts, and define responses to issues. It normally contains an analysis of likely risks with both high and low impact, as well as mitigation strategies that avoid, reduce, accept, or transfer risks partially or completely to third parties.

“**Site professional**” means an engineer responsible for integrating the expertise and work of other engineers and disciplines, and who takes overall responsibility for the site remediation work. This person would normally sign the record of site remediation certificate or equivalent certification depending on the jurisdiction. This person may also be referred to as “coordinating engineer” or “engineer of record” in some jurisdictions.

“**Site-specific remedial objectives**” are established for a specific site to be met by the implementation of a remedial action plan, and, if appropriate, ongoing site management. These are not generic standards prescribed by a jurisdiction, but are normally derived through risk assessment or another form of review.