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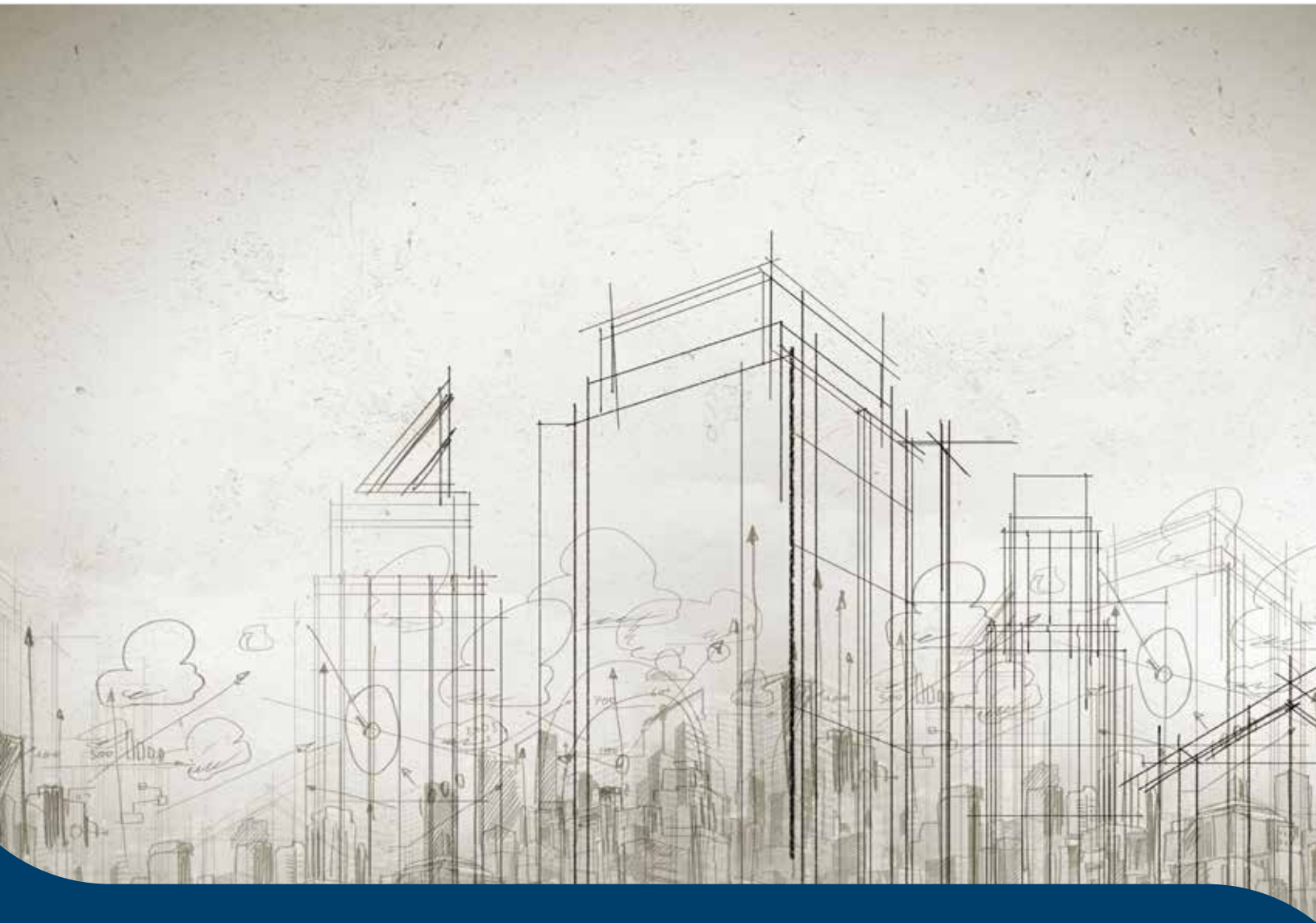

SITE REMEDIATION

Canadian Engineering Qualifications Board

DISCLAIMER

In Canada, individual provinces and territories have complete authority for the regulation of all aspects of the practice of engineering. This means that to practise engineering, it is necessary to apply for and obtain a licence to practice from the engineering association which is the regulatory authority in the province or territory where you wish to practice.

Engineers Canada is a non-profit organization which does NOT regulate the profession. Instead, Engineers Canada assists the provincial and territorial associations in many ways. This includes the preparation of suggested guidelines and examinations.

All documents published by Engineers Canada are developed in consultation with the associations. The documents may be accepted, modified or rejected by the associations.

The reader is welcome to use the information in these Engineers Canada documents, but it is very important to contact the association in the province or territory where you wish to practice for the official policy on all matters related to the admission and regulation of engineering.

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Acknowledgement

This guideline reflects current and best practices of the constituent associations that regulate the profession in Canada. Several have published their own practice guidelines on this subject that reference requirements based on provincial or territorial legislation and regulation. Engineers Canada wishes to acknowledge all of its constituent associations, who have contributed to this document through their best practices and review of this document.

Foreword

Guidelines for areas of engineering practice use the word should to indicate that among several possibilities, one is recommended as particularly suitable without necessarily mentioning or excluding others; or that a certain course of action is preferred but not necessarily required; or that (in the negative form) a certain course of action is disapproved of but not prohibited (should equals is recommended that). The word may is used to indicate a course of action permissible within the limits of the guideline (may equals is permitted).

Constituent associations who wish to adopt and publish a version of this guideline in whole or in part are advised to consider substituting the word shall for the word should to indicate requirements that must be followed (shall equals is required to) to effectively implement in their jurisdiction.

1. Preamble

Provincial and territorial constituent associations of engineers are responsible for regulating the practice of engineering in Canada. Each association/ordre has been established under an Act of its provincial or territorial legislature and serves as the licensing authority for engineers practicing within its jurisdiction. Engineers Canada is the national federation of these associations/ordre, its constituent associations and provides a coordinating function fostering mutual recognition among them and encouraging the greatest possible commonality of operation.

Engineers Canada issues guidelines on various subjects to support the development of common practice guidelines among its constituent associations. Guidelines are an expression of general principles, which have a broad basis of consensus, while recognizing and supporting the autonomy of each constituent association to administer its engineering act.

Engineers Canada guidelines enunciate the principles of the area of practice, and provide general guidance and application on the professional and ethical responsibilities to be considered.

In addition, the guidelines recommend technical applications, policies, practices and exceptions to a level of detail that may be adopted in whole or in part by constituent associations developing their own practice guideline in the subject area.

The guideline has been prepared in accordance with the principles outlined above to assist the constituent associations to carry out their responsibility to protect the public through programs and information that encourage and support the continued qualification of engineers after initial licensure. It reflects current and best practices and policies of the constituent associations in the professional and ethical aspects of engineering practice as it applies to site remediation.

The guideline was prepared by the Canadian Engineering Qualifications Board in consultation with the constituent associations of Engineers Canada.

2. Overview

Engineers are required to conduct themselves in a manner consistent with the engineering Act(s) under which they are registered as engineers. Professional responsibilities are paramount.

Engineers involved in site remediation must be familiar with federal, provincial and municipal legislation, regulations, policies and guidelines that apply to their particular discipline or area of expertise as well as jurisdiction. Permitting processes, approvals requirements and compliance issues will vary, depending on the site and the remediation technology employed. The obligation to be familiar with applicable legislation and processes arises from an engineer's responsibilities.

2.1 Purpose and Scope

This guideline is intended for the constituent associations of Engineers Canada that regulate the practice of engineering in Canada. Its purpose is to outline the professional and ethical issues for engineers involved in site remediation and related 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, 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 provincial, territorial or Federal regulators for the issuance of a remediation certificate or equivalent certification depending on the laws and regulations of the applicable jurisdiction.

The guideline recognizes the multidisciplinary nature of such work, and that other professionals may be involved 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 application of professional judgment is an integral part of doing site remediation work, and

as such, the application of this practice guideline and any association/ordre guideline or standard may vary according to the circumstances. This is a guideline and as such does not replace any existing legislation, regulations, policies or guidelines that exist through the constituent associations of Engineers Canada or provincial/territorial legislators, or preclude the need for appropriate education, training and experience.

This document provides a common framework for constituent associations 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.

The guideline may be adopted in whole or in part by individual constituent associations with a recommendation to substitute the word “shall” for “should” as appropriate to establish an enforceable standard or guideline that is applicable to their licensed engineers.

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.

This guideline does not discuss other aspects of contaminated site cleanup and management, which are often multi-disciplinary and involve other non-engineering disciplines. Constituent associations may wish to include thee 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.

If and when a constituent association implements this guideline, a careful review of legislation and regulations with the guideline should occur to ensure the two do not contradict one another.

2.2 Definitions

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

“Approved professional ” means an engineer who has either specialized technical expertise and responsibility for a portion of the site remediation work 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. May also be referred to as “Contributing Engineer” in some jurisdictions.

“Authentication” means the application of either the engineer’s signature, professional title and registration number, or their stamp/seal and signature, including the date in all cases carried out in accordance with the requirements of the applicable provincial or territorial Engineering Act, by-laws and regulations.

“Client” is the party who engages the coordinating

engineer and, in some cases, the contributing engineer(s) to provide the required professional services in site remediation work. The client may be the owner or a potential buyer of the property or an affected third party.

"Contaminant" means any substance that, when discharged into the environment endangers the health, safety or welfare of persons or negatively impacts the ecology or the environment.

"Contamination" is generally considered to be any organic or inorganic substance released as a result of human activity that has or will exceed locally acceptable levels. Contamination may be present at a site due to a number of 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.

"Direct supervision" is the responsibility of an engineer for the direction, management and conduct of professional services carried out by others.

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

"Engineer", for the purposes of this document, means an engineer who is registered as a member in good standing with any provincial or territorial engineering association.

"Guidelines" are statements issued by provincial/territorial regulators outlining a method, procedure, process or numerical value, which includes the numerical limits or narrative statements that are recommended to protect and maintain the specified uses of water, sediment, soil or air.

"Monitoring" is the regular (e.g. daily, weekly, monthly, quarterly) checking of quality or collection or reporting of information.

"Objective" is a numerical limit, a risk-based limit or narrative statement that has been established to protect or maintain a specified use of water, sediment or soil at a particular site by 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, and a person who holds him or herself as having the powers and authority of ownership or who for the time being exercises the powers of ownership.

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

"Professional sign-off" is the application of an engineer's stamp or seal or membership/registration number, signature and date 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 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 and 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.

"Regulators" are those authorities having jurisdiction over remediation work at the Federal, Provincial or Municipal level of government

"Remediation Action Plan" 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" means the improvement of a contaminated site to prevent, minimize or mitigate damage to human health, ecology or the environment. Remediation involves the development and application of a planned approach that removes, destroys, contains or otherwise reduces the availability of contaminants to receptors of concern.

"Remediation Criteria" are the numerical limits, risk-based standards or criteria or narrative statements pertaining to individual variables or substances in air, water, sediment, soil or soil vapour, which are recommended to protect and maintain the specified uses of the contaminated sites.

"Risk" is a measure of both the severity of human health and ecological health effects arising from exposure to a substance 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.

"Signed and Sealed document" means a document that is signed, and bears an impression of the engineer's stamp or seal that attests to the completeness and accuracy of the document.

"Signature" means the name or personal mark that a person affixes to a document and routinely uses to express consent and acknowledge responsibility to the document or authenticates it. The engineer's signature, when affixed to a document constitutes a signature in accordance with local legislation and regulations.

"Site Professional" means an engineer responsible for integrating the expertise and work output of other engineers 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. 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 other form of review.

"Stamp" or "seal" are equivalent terms for the official mark that is licensed to the engineer registered as a member in good standing by the issuing constituent associations that authorizes them to reproduce it by any means to produce an impression, including procedures that use information technologies.

3. Guiding Principles for Site Remediation Work

The engineer may perform site remediation work for a client, who may be the buyer of a property or the current owner of the property, be it an individual or a company or an affected third party which could include government. 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.

There are fundamental principles that engineers should aspire to and follow when conducting remediation work to provide the highest standard of care for the public. The following sections identify and briefly describe these principles.

3.1 Serving the Public Interest

In all the work that they do, engineers are legally, ethically and morally bound 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, and the public expects and has a rightful role in setting goals for environmental management, even though public expectations are evolving and vary widely. In carrying out remediation work engineers must remember to:

- Hold paramount the public interest, which must take precedence over all other considerations;
- Strike a proper balance between advocating for the client, owner or company versus maintaining objectivity, credibility and the trust of the public

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

3.2 Specialized Technical Knowledge and Skills

Engineers should ensure that they possess a combination of technical 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 constantly improved and enhanced through training and knowledge sharing.

The needed knowledge and skills include but are not limited to:

- Knowledge of local legislation, regulations and guidelines that apply to remediation in the

jurisdiction(s) where the work is being carried out;

- Ability to prepare reports and documents as necessary;
- Awareness and application of alternative remediation strategies and technologies;
- Knowledge and application of remediation standards, processes and protocols

Detailed lists of technical competencies are available from a few associations/ordre that specify the required knowledge and skills. These lists enable the engineer to self-assess their skills and knowledge and serves to remind them of the limits of their competence and the need to practice within those limits. The lists enable planning of additional training to maintain and enhance these competencies. Having such measures in place better assures 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 virtue of their expert knowledge, skills and experience, are held to a higher standard than compared to other professionals, para-professionals, technical and administrative staff, and often fulfil the role of site professional or coordinating engineer.

3.3 Limits of Competence

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

3.4 Using Appropriate Technical Expertise

Remediation projects are often multi-disciplinary and generally carried out by a project team. Certain contaminated sites will require specialized approaches to minimize the potential risk to human and ecological health. In these cases it is essential that the site professional or coordinating engineer is able to recognize when specialized technical expertise is required. These situations may include unique biophysical, chemical, geotechnical or hydrologic circumstances. It requires that all reasonable steps be taken to ensure that the remediation team comprises the necessary expertise and that this expertise is appropriately applied.

Other professionals (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.

3.5 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, consulting with known avenues of information, including databases and government records. It 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.

3.6 Maintaining Standards

Each constituent association 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 association and among peers must be stringent, so that engineers merit societal trust.

Technical and professional standards of conduct are set, revised, maintained, and enforced by the associations/ordre for their registered engineers. Such standards may be provincial, national, or global and address issues of:

Certification and licensure - ensuring only properly qualified members are allowed to practice and do so according to professional standards.

Code of Ethics - holding protection of the public from unethical and/or incompetent practice in highest esteem.

- 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.

3.7 Increasing Complexity and Specialization

Site remediation work involves the design and execution of many steps, which 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 requires the work to be divided into smaller segments and assigned to various employees and contractors. This complexity requires the engineer to uniquely evaluate each and every situation based on a number of factors that include:

- Level and quality of the site assessment information;
- Former, current and intended uses for the site;
- Site conditions which include, but are not restricted to, the geology, hydrogeology, soil conditions, type(s) and fate and transport of contaminant, existing buildings and structures etc.;
- Available budget, schedule and human resources;
- Availability and costs of appropriate technologies and remediation techniques;
- Jurisdictional considerations i.e. which regulations and standards govern the site;
- Applicable permitting processes, approval requirements and compliance issues;
- Liability considerations;
- Who the client is (landowner, buyer or company) and what are their objectives.

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 industry and recognition by regulators. Engineers are encouraged to consider such alternatives even in jurisdictions which do not yet require it.

3.8 Compliance with Regulatory Requirements

Regulatory requirements include compliance with municipal and provincial acts and regulations as well as Federal laws and regulations that are applicable to the site. The engineer should be aware of the applicable acts and by-laws from all three levels of government

Federal, provincial and territorial regulatory frameworks that govern site remediation in their respective jurisdictions are subject to change every few years to accommodate new scientific knowledge, advances in technologies, standards and processes as well as new and variable site conditions and associated environmental impacts. It is incumbent upon the engineer to review and learn any revised regulations 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.

3.9 Accountability to Multiple Stakeholders

Engineers are accountable to many different stakeholders in site remediation work. The many levels of accountability and methods to control it include:

- the public, through services provided with a feedback loop through the courts on issues of safety and liability,
- the regulator, who has power of enforcement of legislation and regulations,
- self and the profession, through the Code of Ethics ensuring ethical behaviour and skilled practice,
- the employer/client/supervisor, through the employment contract, and
- the shareholders, through the market place.

Further, as professionals, engineer's actions are influenced and controlled by insurers through 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 relatively autonomous to choose 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 competence that may affect a professional employee's ability to maintain highly professional behaviour. Thus, the characteristics that identify a professional – autonomy, commitment, identification, and ethics – may be influenced because the professional answers directly to the employer and less frequently to the client and professional association.

Whether engineers are employers, supervisors, clients, or employees in this equation, 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 Specific Objectives and Remediation Targets

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

Before objectives are set, the engineer should confirm the client for the remediation work, be it the owner, buyer, a company or local government and establish their 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. The objectives may range from preparing the site for sale, or modifying it for a new use that is either allowed by the current zoning by-law, or through application for a zoning by-law change or compliance with an environmental order.

When setting site-specific objectives the engineer should consider:

- The engineer's obligation to serve the public interest as paramount and their Code of Ethics
- Current and future land use
- Availability, appropriateness and cost of remediation technologies
- Available budget
- Timeframe for remediation
- Risk tolerance of the client or owner

The setting of objectives includes meeting remediation targets, which may include remediation criteria. These criteria are typically produced by, and enforced by, provincial and territorial governments. Generic criteria are most commonly developed for media such as soil, groundwater, surface water, air and sediment and these levels should be available through provincial/territorial websites. The engineer needs to be aware of these criteria for the jurisdictions in which they are planning site remediation work as well as the limitations of generic criteria in order to apprise the client of a criteria-based approach to site remediation.

Compatible remediation targets will also be influenced by:

- Public interests
- Valid ecological concerns
- Regulatory requirements
- Corporate objectives and policies

Critical to setting remediation targets is proper site characterization through a Site Assessment. For the purposes of this guideline it is assumed that Phase II Site assessment has been completed to the standard required by the applicable provincial or territorial legislation and available to the engineer planning site remediation. This being said, there

may be some conflict of interest in the level of work done for Site Assessment versus Site Remediation. This may be resolved by clarifying the level of responsibility between the client, site assessment contractor, regulator reviewer, site remediation contractor and the final approval of the work by the regulator as part of the Remediation Action Plan that is described below. Such clarification should be an early step in the remediation planning process, particularly if the engineer was not directly involved in the site assessment work.

The Site Assessment and any follow-up site investigation should provide a sufficiently complete picture of local hydrogeologic and geologic conditions, and clarify the type and distribution of contaminants. This framework serves as the informed basis for all other activities, including remediation targets.

If the engineer believes that there is insufficient information from the Site Assessment, or the date of the assessment is such that there is a possibility that conditions have changed, 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.

In general, there are three approaches that can be used to determine targets for site remediation:

1. Remediation to background condition;
2. Remediation to comply with established criteria;
3. Remediation to comply with criteria established through site-specific risk assessment techniques.

Remediation to background condition restores the site or property to an environmental condition consistent with ambient or background conditions.

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, ground water, surface water, air and sediment.

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 particular site, based on the conditions 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. 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 are difficult to present.

The overall result is that the coordinating engineer managing a risk assessment project should have the necessary experience and background that includes a sound understanding of the risk assessment process and 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 limitations of risk assessment. The coordinating engineer may be required to sign documents or affidavits that characterize the site, the findings of the risk assessment or summarize the risk management measures to be taken.

There may be situations where only partial remediation of a site is possible or being undertaken. Such projects may be difficult to get a remediation certificate from the regulator which may prohibit a professional sign-off or other site certification mechanism that is applicable. An example would be an interim or partial remediation with full cleanup at a later date. In such cases the engineer may be required to sign-off on the project to indicate that the remediation is complete to the initially approved scope of work. In such cases the engineer signing off on the project should clearly identify any impacted areas not addressed in the project are clearly identified through a letter that accompanies such a sign-off.

4.2 Identification and Evaluation of Remediation Alternatives

This step in site remediation generates a range of alternatives for subsequent detailed analysis. Not every site remediation involves excavation and landfill disposal operation. Alternatives may involve the complete elimination or destruction of identified hazardous materials, reductions of concentrations to acceptable levels (or to meet remediation criteria), prevention of exposure to hazardous materials through engineering or institutional controls or some combination of the above.

Pilot-scale remediation technology testing can be a critical, but not necessary step in the implementation process of a remedial option. Each site is somewhat unique, and therefore treatment should be tested on a small scale before committing the potentially substantial financial resources that may be needed for full-scale implementation of remedial programs.

Using technical and economic analysis, possible remediation alternatives are evaluated and compared. 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.

Often there will be only one method that is technically feasible or obvious, in which case the engineer may proceed directly to the next step, which is normally the preparation of a Remediation Action Plan.

4.3 Site Remediation Action Plan

Once a preferred remediation alternative is selected, a site Remediation Action Plan that provides a description of the project to the preliminary design stage would be prepared. Such a document would describe the plans for implementing the selected remediation alternative, and serve as the basis for discussing implementation with the client, owner, regulatory authorities and/or other stakeholders. In some jurisdictions there is a requirement to submit an RAP for approval prior to commencement of the remediation work.

The Remediation Action Plan would normally include:

- Description of objectives and remediation targets, including any specific remediation criteria to be achieved;
- Overview of the site contamination;
- Description of the media/materials to be remediated;
- Options that appear to be best suited to remediate specific conditions;
- Risk management plans;
- Description of the issue resolution process;
- Types of pilot-scale tests to confirm the viability of specific options, including treatment equipment;
- Estimates of time and cost to initiate and complete remediation;
- Description of remediation strategy;
- Description of regulatory approval requirements;
- Public communications plan;
- Construction plans;
- Design and tendering of remediation work;
- Management of accumulated water, dust, noise and traffic;
- Environmental/emission monitoring;
- Confirmatory sampling;
- Site-specific health and safety plan;
- Contingency plans;
- Identification of the fate of residual contaminants;
- Remediation verification and long-term monitoring plans;
- Mobilization and site preparation;
- Materials handling
- Management of by-products;
- Project schedule/duration;
- Site restoration and closure process;

- Reporting/documentation requirements;
- Key contact information.

Risk management plans are recommended practice in all jurisdictions and are an evolving element of this work. These 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 overestimated. There

are many occasions where additional information not previously identified or obtained in 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:

How would discoveries of potential off-site impacts be handled? Would they be different for private 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 can be developed 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 regulatory approvals.

The plan may include applying for permits and approvals for decommissioning or demolition of building structures and/or equipment as well as for the remediation of solid, liquid or gaseous matrices.

4.4 Implementation of Remediation Action Plan

Steps involved in executing the Remediation Action Plan include:

1. Preparation of Specifications and Tender Documents, Contractor Selection;
2. On-site supervision;
3. Alternate Project Delivery.

On-site supervision is usually essential during remediation operations to ensure the client's interests are addressed, ensure the contractor is executing the remedial action plan as specified in the contract and to develop remediation verification information. Periodic progress should be undertaken to ascertain if objectives and remediation targets are being met. If activities deviate from the Remediation Action Plan or objectives and targets are not achieved, the engineer should advise the client or owner. Further corrective actions should be documented.

Alternate 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.

Fully integrating the technical and project management functions can implement a remediation program efficiently and successfully, with project goals fully in mind. Optimal technologies from the pilot-testing phase are implemented, and progress is evaluated over time through careful monitoring. The system is maintained and modified, as necessary, to optimize site remediation and to ensure cost-efficiency.

4.5 Verification and Documentation

Verification sampling of the remediated areas/materials should be undertaken to ensure effective remediation. Thorough documentation including verification data should be sufficient to demonstrate that the objectives and remediation criteria have been met.

Registering post-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.

4.6 Authentication

Stamping and sealing, signing and dating (collectively referred to as "authentication") of engineering documents, is a requirement under all provincial and territorial Engineering Acts and Regulations. An "engineering document" consists of information recorded on a medium, which may be either a traditional medium e.g. paper or film or one based on information technology (whether magnetic, digital, optical or electronic, or a combination of these technologies etc.). The principles involved in authenticating engineering documents are similar and are independent of the methods employed for producing the document.

An engineer must authenticate the originals of all 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 title.

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, with an indication or qualification of which the seal implies discipline.

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. Each engineer

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 Remediation Action Plan, 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; and
- regulators, other professionals, and the public may rely upon the work.

4.7 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. However, long-term or on-going 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 on-going risk does not remain.

4.8 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 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 regulator would conclude the process by issuing a letter advising that no further remediation is required.

5. Responsibilities of the Involved Parties

5.1 Responsibilities of the Client

In order for engineers to carry out remediation, the client (which may be a company or seller of the property) should undertake the following:

- Define or work with the coordinating engineer to define the scope of work and deliverables, ensuring that the scope of any relevant site assessment is adequate to identify all likely areas of potential environmental concern and contaminants of potential concern.
- Clarify the roles and responsibilities of the various professionals, para-professionals and remediation contractors involved in the remediation work;
- Before work starts, complete a written agreement with the coordinating engineer confirming the scope, compensation, and schedule for the services.
- Disclose fully and promptly to the engaged coordinating engineer all information (written or otherwise) related to the remediation work (e.g., operational history of the site).
- 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.
- Recognize potential need for clarification or additional work associated with the reports, plans and assessments submitted for review before the engineer is able to provide authentication of these or other documents such as a remediation certificate application.
- Ensure that all appropriate documents are submitted to the regulator. If there are any outstanding issues, the client should discuss these with the coordinating engineer before the application is submitted to the regulator.

5.2 Responsibilities of the Owner

The owner's responsibilities are the same as the client. In this case the owner is not the buyer. All processes and responsibilities are the same; however, the owner has further responsibility to grant unimpeded access to the site.

5.3 Expectations of the Regulators

The engineer carrying out remediation work should expect the regulators 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 in the development and implementation of policies and regulations related to remediation.
- Process site remediation reports and issue letters of closure.

The first step undertaken by regulators receiving a site remediation report consists of checking to ensure 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 engineer may expect the regulator to complete one of two types of review:

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

Audit Review - typically designed by the regulator and conducted to determine compliance with legislation, criteria, guidelines and policy.

Early and continuing dialogue with the regulator by the coordinating engineer should be emphasized throughout all the steps of planning, executing and approving a site remediation.

5.4 Responsibilities of Associations/ Ordre

The associations/ordre that regulates the practice of engineering in their respective jurisdictions have a number of responsibilities in regulating the engineering elements of site remediation work. These include practice standards and guidelines, defining and administering the code of ethics as well investigating complaints and disciplining engineers if standards for remediation work or ethics have been breached.

In addition each association/ordre promotes, and in some cases, maintains records of continuing professional development of engineers through on-going continuing professional development programs.

5.5 Responsibilities of the Engineer

The engineer, regardless of his or her role in the scope of remediation work, has the primary duty for protection of the public and has a duty to conduct their 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 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 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. 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.

If, during the course of 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 regulator and/or the appropriate constituent associations.

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 systematic or intentional bias exists in the data.

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

If the engineer encounters aspects of remediation that differ from the 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 regulators prior to submitting remediation documentation e.g. a certificate application.

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

5.6 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 a number of 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:

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.

Contributing Engineer

Such individuals are selected based on the needs of the remediation project. Selection may be by the coordinating engineer or the client/owner, based on evaluation of their 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 applicable reports. The sign-off documentation of contributing engineers should be maintained in the project file.

Other Professionals

Individuals with scientific expertise in natural sciences or other professional disciplines are sometimes required. Such individuals may or may not be registered with a professional regulatory body. 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 on the basis of knowledge, experience and record on past projects, and check on any professional qualifications, if available and applicable.

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 them.

5.7 Responsibilities of the Coordinating Engineer

The coordinating engineer is normally responsible for all aspects of remediation including coordination, planning/design, field reviews, site plans, and QA/QC. The work of the coordinating engineer may include the review and assurance of work conducted by the coordinating engineer under his or her direct supervision or a review of the work conducted by others, or a combination thereof.

Responsibilities of the coordinating engineer include, but are not limited to the following:

- Confirming the overall quality of the analytical data set, that the Quality Assurance/Quality Control program meets standards, and that the analytical data support the conclusions regarding field conditions.
- Reviewing investigations, plans, assessments, reports, and other documents which document the site condition; determine if these materials support the conclusions regarding the compliance of the site with applicable guidelines and standards; and ensure that these documents are submitted along with the application for a regulatory approvals e.g. a remediation certificate. The final accountability to the public and regulators lies with the coordinating engineer authenticating the application.
- Applying professional and responsible judgment in interpreting the work of contributing engineers.

- Bringing deficiencies in previous or current work to the attention, in writing, of the client. A coordinating engineer cannot take responsibility for work outside of his or her scope of practice. He or she must rely on the appropriate contributing engineer(s) and other professionals.

The coordinating engineer should construct a suitable team structure and management plan to ensure that the work and the associated responsibilities are distributed appropriately.

5.8 Responsibilities of the Contributing Engineer

The contributing engineer has responsibility for conducting or preparing a portion of the site remediation work as delegated to them 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. They should be vigilant in selecting a process or assembling a team to apply sufficient and appropriate knowledge and experience.

6. Quality and Risk Management

The management of 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 with appropriate risk management plans in place to deal with them.

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

- Well-developed objectives and scope;
- Allowing 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;
- Ensuring that timelines are appropriate;
- 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. They should ensure that such a situation is handled through professional liability insurance and/or employer/contractor/client liability insurance.

6.2 Quality Assurance and Quality Control

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

A QA/QC program will be 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 through 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 regulator.

Some examples of Quality Assurance/Quality Control measures commonly employed in site remediation include:

- Project management strategy such as ISO
- 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 their portion of the remediation work, the engineer should state any limitations or assumptions made in the performance of such work.

6.4 Documentation and Reporting

The engineer should be aware that documentation and reporting requirements may differ between the client and the regulator. Meeting regulatory

requirements should always take precedence to adequately protect the public.

There is a possibility that an engineer's report may be submitted 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 regulatory authority. In such situations, the engineer is advised to consult with their association/ordre 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 and 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 associations/ordre 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 responsibilities in reviewing another engineer's work. Several associations/ordre provide guidance for such reviews through published guidelines

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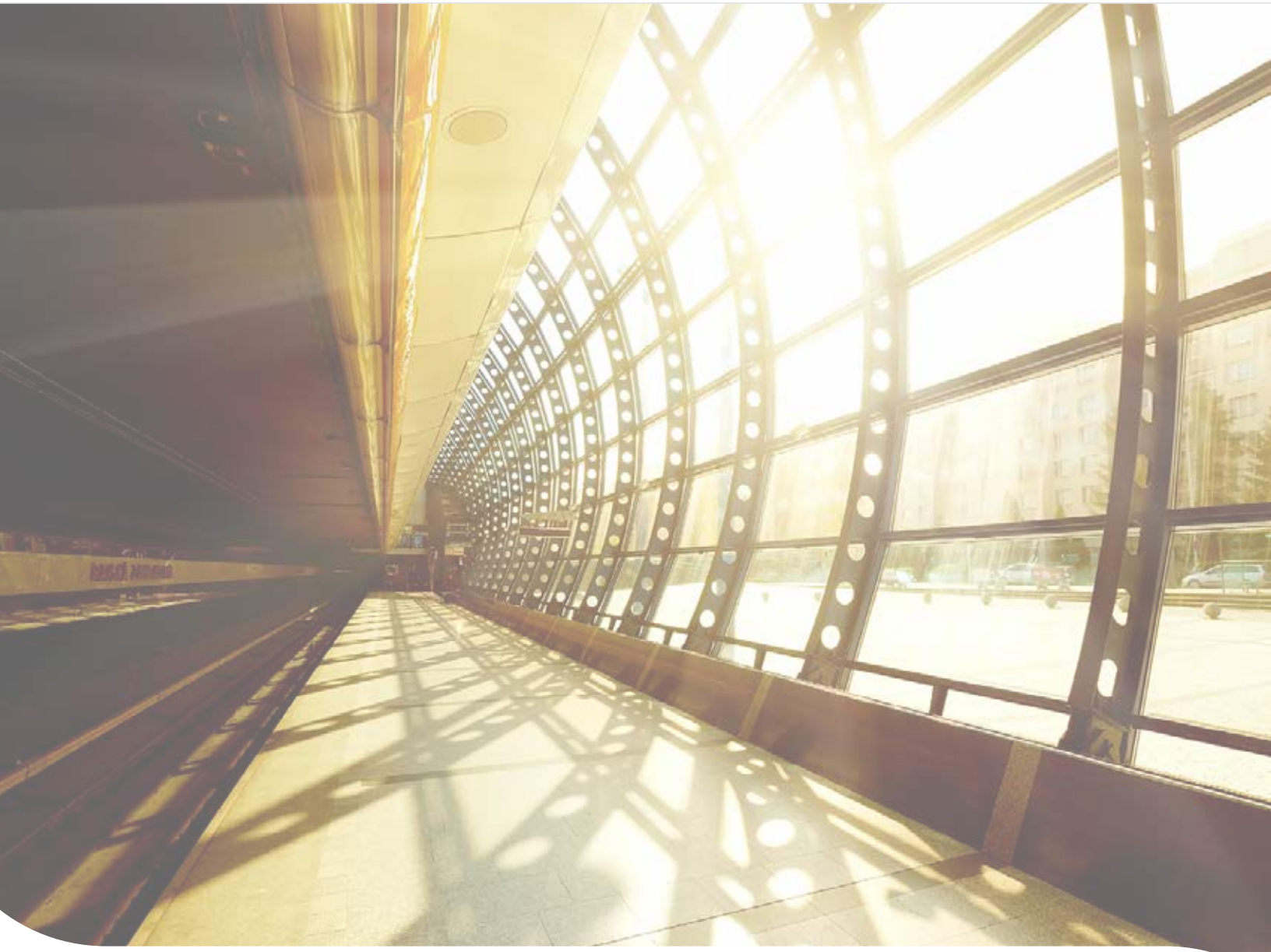

Engineers Canada
180 Elgin Street, Suite 1100, Ottawa, ON
K2P 2K3 Canada
(613) 232-2474
ceqb@engineerscanada.ca
www.engineerscanada.ca