

CONTAMINATED SITES

Guidelines for the
NSW Site Auditor Scheme
(2nd edition)

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PREFACE

Industrial, agricultural and other commercial activities can sometimes result in the discharge of chemicals to the environment which accumulate in soil, sediments, groundwater or surface water. Some of these chemicals can remain in the environment for a long time. In some places they are present at levels that can have an adverse impact on human health or the environment and impede the productive use of land or water.

Planning authorities need information about a site's known or suspected history of potentially contaminating activities to be able to decide whether the land is suitable for an alternative use, such as residential or commercial development. They must be sure that the levels of any chemicals in the environment are within acceptable limits and that the land is suitable for its proposed use. In some cases the land and its immediate environment may have to be remediated to make it suitable.

The assessment and remediation of contaminated sites, usually conducted by contaminated site consultants, is technically difficult because of the complex behaviour of chemicals in the environment and their effects on ecosystems and human health. Obtaining dependable information for making reliable decisions can be difficult. It is therefore important that planning authorities and developers have access to advice from appropriately qualified and experienced people in making their land-use planning and development decisions.

To improve access to competent technical advice and increase certainty in the assessment and remediation of contaminated sites, the NSW Government introduced the NSW Site Auditor Scheme in 1998.

Under the scheme, the management of contaminated sites involves both contaminated site consultants and accredited site auditors. Contaminated site consultants, typically engaged by the site owner or developer, conduct site assessments, undertake any necessary remediation and validate their work. Accredited site auditors independently review these consultant activities to ensure the work complies with current regulations and guidelines and meets the standard appropriate for the proposed land use. It is highly desirable that a site auditor is engaged as early in the assessment and remediation process as possible, as early communication between parties to the project improves the efficiency of the audit, usually reflected in timeliness and cost savings.

These *Guidelines for the NSW Site Auditor Scheme* apply to individuals seeking to be accredited as site auditors in NSW and to those already

accredited. They may also be of use to other people with an interest in contaminated sites, such as contaminated site consultants and local councils, as guidance on what is expected of site auditors whom they may engage or whose work they may assess.

These guidelines consist of four sections:

1. Introduction to the NSW Site Auditor Scheme
2. Accreditation and renewal of accreditation
3. Conducting site audits
4. Contamination assessment, remediation and management.

Appendices provide additional technical and administrative information relating to the scheme.

These guidelines have been made in accordance with the *Contaminated Land Management Act 1997*. They should be read in conjunction with that Act, the Contaminated Land Management Regulation 1998 and any guidelines made or approved by the Department of Environment and Conservation (DEC) under the Act.

The guidelines were first published in 1998 and have been updated to reflect comments received about them by DEC and the experience gained by DEC through administering the scheme. More detailed guidance for both site auditors and contaminated site consultants can be found in the Appendices.

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I INTRODUCTION TO THE NSW SITE AUDITOR SCHEME

I.1 Objectives

The objectives of the NSW Site Auditor Scheme are to:

- ensure that public health and the environment are protected through proper management of contaminated sites, particularly during changes of land use
- improve access to technical advice on contaminated sites for planning authorities and the community by establishing a pool of accredited site auditors
- provide greater certainty for planning authorities and the community through the independent review by those auditors of contaminated site assessment¹ and remediation reports, and reports that validate the successful completion of the assessment or remediation.

I.2 Background

In Australia, the use of accredited auditors to review work conducted by contaminated site consultants² was first introduced in Victoria in 1989 through the Victorian EPA's Environmental Auditor (Contaminated Land) Scheme.

In 1998, NSW commenced its own Site Auditor Scheme under the *Contaminated Land Management Act 1997* (CLM Act). The scheme is administered by the Department of Environment and Conservation (DEC).³

The CLM Act empowers DEC to accredit individuals as site auditors⁴ and to establish guidelines for them.

The Contaminated Land Management Regulation 1998 (CLM Regulation) specifies some of the procedural requirements of the scheme.

1 In these guidelines 'assessment' includes the investigation of a site and drawing conclusions about the contamination of a site in light of that investigation.

2 Within the context of these guidelines, 'contaminated site consultants' means individuals or corporations engaged to carry out the assessment, remediation, management and validation of contaminated sites.

3 In these guidelines references to 'DEC' should be read as referring also to the Environment Protection Authority. It is the latter, rather than DEC, which has the powers and functions under the *Contaminated Land Management Act 1997* and the *Mutual Recognition (New South Wales) Act 1992*.

4 Within the context of these guidelines, a 'site auditor' means any individual accredited as a site auditor under Part 4 of the CLM Act.

A list of site auditors accredited under the CLM Act is available from the DEC website at www.environment.nsw.gov.au or by phoning Environment Line on 131 555 (within NSW) or (02) 9995 5000.

1.3 Site audits in relation to contaminated sites

Site auditors review the work of contaminated site consultants. The CLM Act calls these reviews '**site audits**' and defines a site audit as an independent review:

- (a) that relates to investigation or remediation carried out (whether under the CLM Act or otherwise) in respect of the actual or possible contamination of land,⁵ and
- (b) that is conducted for the purpose of determining any one or more of the following matters:
 - (i) the nature and extent of any contamination of the land
 - (ii) the nature and extent of the investigation or remediation
 - (iii) whether the land is suitable for any specified use or range of uses
 - (iv) what investigation or remediation remains necessary before land is suitable for any specified use or range of uses
 - (v) the suitability and appropriateness of a plan of remediation, a long-term management plan, a voluntary investigation proposal or a remediation proposal.

The main products of a site audit are a 'site audit statement' and a 'site audit report'.

A **site audit statement** is the written opinion by a site auditor, on a DEC-approved form, of the essential findings of a site audit. It includes, where relevant, the auditor's conclusions regarding the suitability of the site for its current or proposed use. The current approved site audit statement form can be found on the DEC website at www.environment.nsw.gov.au/clm/auditorscheme.htm.

Before issuing a site audit statement, the site auditor must prepare and finalise a detailed **site audit report**. The report must be clearly expressed and presented and contain the information, discussion and rationale that support the conclusions in the site audit statement.

In some circumstances a site audit is required by law. These audits are known as '**statutory site audits**' and may be carried out only by site auditors accredited under the CLM Act. A statutory site audit is one that is required by:

⁵ The CLM Act defines 'land' to include 'water on or below the surface of land and the bed of such water'.

- a regulatory instrument issued under the CLM Act, including DEC agreements issued by DEC to voluntary proposals
- the *Environmental Planning and Assessment Act 1979*, including an environmental planning instrument or development consent condition
- any other Act.

The requirements that site auditors must follow in conducting site audits and preparing site audit statements and site audit reports are outlined in Sections 2–4 of these guidelines.

1.4 Role of site auditors

The services of a site auditor can be used by anyone who needs an independent and authoritative review of information relating to possible or actual contamination of a site. The review may involve independent expert technical advice or ‘sign-off’ of contaminated site assessment, remediation or validation work conducted by a contaminated site consultant.

It is imperative that a site auditor is engaged as early in the site assessment and remediation process as possible. Early communication between the land owner or developer, consultant and site auditor improves the efficiency of the audit process by ensuring all environmental issues have been addressed to the satisfaction of the auditor, in an appropriate manner and in accordance with guidelines made or approved by DEC.

However, as outlined in greater detail later in these guidelines, it is very important that an auditor’s involvement is not such that their review is effectively a review of their own work as this would compromise the independence and objectivity of the audit.

1.5 Site assessment and audit process

The usual stages in the assessment, remediation and validation of a contaminated site, and in the audit of those activities, are as follows:

1. Consultant is commissioned to assess contamination

In most cases, a site owner or developer engages a contaminated site consultant to assess a site for contamination and, where required, to develop a remediation plan, implement the plan and validate the remediation.

The contaminated site consultant designs and undertakes the site assessment and, where required, all remediation and validation activities to achieve the objectives specified by the owner or developer.

Before undertaking their work, consultants should refer to the *Guidelines for Consultants Reporting on Contaminated Sites* (EPA 1997) and other relevant guidelines made or approved by DEC. The 1997 guidelines provide a brief description of the various stages of contaminated site assessment, remediation and validation, and list information that should be included in consultants' reports.

2. Site auditor reviews the consultant's work

The site owner or developer commissions the site auditor to review the consultant's work. The auditor prepares a site audit report and a site audit statement at the conclusion of the review, which are given to the owner or developer.

Where the local planning authority or DEC uses its legal powers to require the carrying out of a site audit, the site owner or developer must commission a site auditor accredited under the CLM Act to perform this task. This is known as a 'statutory' audit. The CLM Act requires that an auditor must notify DEC when he or she has been commissioned by anyone other than DEC to perform a statutory site audit. The auditor is also required to furnish the local authority and DEC with a copy of the completed site audit statement.

In some cases, the site owner or developer may wish to have a site audit undertaken although it is not a legal requirement. The audit is termed 'non-statutory'. If their intention is to obtain a site audit statement, they must commission a site auditor accredited under the CLM Act to perform this task. This is because only a site auditor so accredited can issue a site audit statement and they are obliged to issue one at the end of any site audit. For non-statutory audits, the site auditor must give a copy of the site audit report to the local authority or DEC, or both, on request.

As required by the CLM Act, DEC maintains a record of all statutory site audit statements issued in relation to land that is the subject of a regulatory instrument under the CLM Act. Copies are available for public inspection through DEC's website at www.environment.nsw.gov.au. If the local council receives a copy of a site audit statement, it must list the statement on any certificate it issues under section 149 of the *Environmental Planning and Assessment Act 1979* in relation to the land concerned.

Section 3.2 outlines the site audit process in greater detail.

I.6 Role of DEC

DEC is responsible for:

- establishing selection criteria and processes for accrediting competent individuals as site auditors and renewing their accreditation
- developing regulations relating to site auditors
- developing guidelines for site auditors, contaminated site consultants, local government and the community on the investigation and remediation of contaminated sites
- conducting reviews of the performance of site auditors to ensure that the required standards are maintained, and taking any necessary disciplinary action.

DEC also works with the Department of Planning in the development of land-use planning guidelines relating to contaminated sites.

I.7 Using these guidelines

In doing audit work, including the preparation and issuing of site audit statements and site audit reports, accredited site auditors must comply with the mandatory aspects of these guidelines. The mandatory aspects are indicated throughout the guidelines as something that the auditor '**must**' do or refrain from doing. Site auditors must also be able to demonstrate to DEC's satisfaction, if required, that they have complied with these aspects. This applies to any site audit undertaken by a site auditor, whether it is a statutory or non-statutory audit.

Aspects of the guidelines that are recommendations to site auditors and not mandatory are indicated in the guidelines as something that the auditors '**should**' do or refrain from doing. Site auditors are expected to exercise their professional judgment in these areas and clearly document in the site audit report the reasoning that supports their conclusions.

2 ACCREDITATION AND RENEWAL OF ACCREDITATION

This section outlines the requirements that individuals must satisfy before they can be accredited as site auditors or have their accreditation renewed under the CLM Act. It also outlines some of the quality control mechanisms that are used by DEC to maintain the integrity of the scheme.

2.1 Application process

There are two ways to apply for accreditation as a NSW site auditor. Applications can be made under:

- the *Contaminated Land Management Act 1997*, or
- the *Mutual Recognition (New South Wales) Act 1992*.

DEC does not set a limit on the number of site auditors who can be accredited under the NSW Site Auditor Scheme at any one time.

Only individuals can be accredited as site auditors, a body corporate cannot.

Special arrangements apply where an application is made under the Mutual Recognition Act: see Appendix III. The following sections deal with applications under the CLM Act.

2.1.1 Submitting an application for accreditation

DEC anticipates inviting applications for accreditation under the CLM Act at least once every two years.

Applications must be made on the form available from DEC, sent to the person and address identified in the advertisement and received by DEC with the application fee before the advertised deadline. Late applications will not be considered.

Applications will be accepted for consideration by DEC if they include:

- (a) Six copies of:
 - (i) the applicant's curriculum vitae, including full name, address, phone number, fax number, certificates evidencing professional qualifications (either the original or a certified copy of the original), employment history, and evidence of membership of any relevant professional associations in Australia
 - (ii) a statement clearly addressing all selection criteria

- (iii) contact details of two referees who are not associated with the applicant's employer, and who have direct and recent knowledge of the applicant's contaminated sites work
 - (iv) synopses of projects (listed in chronological order) in which the applicant has made a major contribution to the design, implementation, scientific analysis and reporting of contaminated site assessments, and which describe the applicant's role in the projects and their work and field activities
- (b) Two copies of each of two reports prepared by the applicant on contaminated site management and/or remediation projects which clearly demonstrate the applicant's expertise in advising on the assessment and remediation of contaminated sites and their role in undertaking the project and preparing the report. (Consent from those who commissioned the reports should be obtained before sending them to DEC which treats all reports sent to it in relation to site auditor applications as confidential and returns them to the applicant.)
- (c) A cheque for the prescribed application fee, currently \$285, made out to the Department of Environment and Conservation NSW.

DEC may seek further information from the applicant, refuse to consider an application or postpone considering an application if it considers any of the statements or information in the application to be unsatisfactory, materially false, misleading or incomplete.

2.1.2 Selection criteria

DEC may refuse an application for accreditation if, in its opinion, the applicant does not satisfy the requirements in these guidelines on eligibility for accreditation or for any other reason it considers sufficient. Accreditation can also be refused if within the two years preceding the application DEC revoked or refused to renew the applicant's accreditation as a site auditor.

DEC will consider the recommendations of the accreditation panel (see Section 2.1.4 below) in deciding whether to grant accreditation.

To be eligible for accreditation the applicant must demonstrate, to DEC's satisfaction, in their application and any associated examination and interview that they have:

- (a) a relevant bachelor's or higher degree from a recognised college or university

- (b) at least five years' broad experience in contaminated site assessment and remediation involving a wide range of contamination in various media, including at least two years of relevant experience in Australia and two years as a supervisor or project manager
- (c) a good understanding of:
 - (i) contaminated site assessment
 - (ii) soil sampling, and soil sampling design and methodology
 - (iii) groundwater sampling, and groundwater sampling design and methodology
 - (iv) interpretation of analytical data
 - (v) quality assurance and quality control procedures
 - (vi) assessment of contaminant exposure pathways and risks
- (d) a good understanding of the impacts of contaminated sites on:
 - (i) the environment
 - (ii) public health
 - (iii) worker health
- (e) a good understanding of NSW legislation relating to contaminated sites, environment protection and planning (see Appendix IX)
- (f) a good understanding of national and NSW guidelines, policies and legislation relating to contaminated sites, for example:
 - *Australian and New Zealand Guidelines for the Assessment and Management of Contaminated Sites* (ANZECC & NHMRC 1992) and updates
 - *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC & ARMCANZ 2000)
 - *National Environment Protection (Assessment of Site Contamination) Measure 1999* (NEPC 1999)
 - *Managing Land Contamination: Planning Guidelines* (DUAP & EPA 1998)
 - *State Environmental Planning Policy No. 55: Remediation of Land* (DUAP 1998)
 - *Environmental Guidelines: Assessment, Classification and Management of Liquid and Non-liquid Wastes* (EPA 1999)

- Chemical Control Orders (CCOs) issued by DEC under the *Environmentally Hazardous Chemicals Act 1985* (see Appendix IX)
- all contaminated sites guidelines and policies issued by DEC, including these guidelines (see Appendix IX)
- any other guidelines made or approved by DEC under the CLM Act (see Appendix X)
- relevant guidelines and monographs issued by the enHealth Council, the National Health and Medical Research Council (NHMRC) and the Environment Protection and Heritage Council
- relevant national environment protection measures (NEPMs).

(Note: This list is not exhaustive. Reference should also be made to other documents listed in Appendix XI.)

- (g) a good understanding of the methods and tools used for assessing, remediating and managing contaminated sites
- (h) access to a support team with expertise in any of the following areas in which the auditor is not expert:
 - geotechnology and hydrogeology
 - environmental and analytical chemistry
 - soil science
 - ecotoxicology and toxicology
 - contaminant fate and transport
 - exposure assessment
 - data evaluation
 - environmental sampling
 - risk evaluation
 - remedial technologies and associated requirements.

(Applicants must give details of their access to technical resources, including services and personnel in each of the above areas. Australian-based resources are preferred. All support team members must have appropriate academic qualifications and a thorough knowledge of relevant Australian guidelines and policies. Detailed curriculum vitae for all support team members, both external and internal, will be required prior to accreditation together with a consent letter from suppliers of external resources. At each renewal of accreditation, confirmation of the composition of the support

team and their willingness to continue in their role will be required. Auditors must allocate each of their support team to one or more of the specific areas of expertise listed above.)

- (i) an up-to-date knowledge of relevant scientific literature
- (j) access to an insurance policy for professional liability that will cover their site audit work (minimum \$5 million) (see Section 2.6)
- (k) proven high standards of integrity and objectivity – successful applicants will be required to complete the declaration in Appendix VIII to this effect before they receive accreditation.

2.1.3 Assessment of applicants

The general procedures outlined here may be varied from time to time in the light of any changes to legislation and administrative processes. Any such changes will be advised to all prospective applicants well ahead of their implementation.

All applications will be assessed against the above criteria by DEC and the accreditation panel. They will consider whether they are satisfied with the standard of an individual's application, including whether it addresses all the selection criteria. The manner in which the application does so will also be considered (for example, whether the selection criteria are clearly and directly addressed and the application is clearly expressed and logically set out). This is because clarity, logic and comprehensiveness are important qualities expected by DEC in an auditor's written work.

Individuals whose applications are considered by DEC to meet the selection criteria will generally be invited to sit a written examination. The examination will cover legislative, technical and policy aspects of contaminated site management, including, but not limited to, the following:

- regulatory requirements applicable to the assessment, remediation, validation and management of contaminated sites
- site investigation techniques
- quality assurance and quality control
- chemicals and their behaviour in the environment
- remediation techniques
- how to assess sampling data and reports
- analytical reasoning and decision-making skills.

Applicants who have demonstrated a good understanding of these aspects based on the results of the examination will generally be invited to attend an interview with the accreditation panel. The interview will typically comprise consideration and discussion of a case study. However DEC may vary the format of the examination and interview from time to time. Applicants will be advised of any changes well in advance of the examination and interview.

At the interview, the accreditation panel will consider whether an applicant:

- has the capacity to conduct a site audit in a logical and objective way
- can critically review information on contaminated site assessment and remediation
- is able to provide a clear rationale for their conclusions.

2.1.4 Accreditation panel

The accreditation panel advises DEC on the suitability of applicants for accreditation. The panel is appointed by DEC and has at least four members:

- a DEC officer who chairs the panel
- a representative of community environmental groups appointed on the nomination of the Nature Conservation Council of NSW
- a representative of industry
- a representative of academia with tertiary qualifications in a discipline relevant to contaminated sites.

DEC may also appoint additional technical or policy experts to the accreditation panel. Panel members hold office for a period not exceeding five years but are eligible for re-appointment.

2.1.5 Period of accreditation

Applicants granted accreditation are entitled to practise as an accredited auditor for the term specified in the notice of their accreditation. The CLM Act allows DEC to grant accreditation to auditors for any period up to three years. Newly appointed auditors are generally accredited for an initial period of one year.

2.2 Accreditation conditions

DEC may attach conditions to a site auditor's accreditation. Auditors must comply with all conditions of their accreditation. Failure to do so is grounds for their accreditation to be suspended, revoked or not renewed.

2.3 Renewal of accreditation

A site auditor's accreditation is not automatically renewed at the end of their accreditation term. Auditors must formally request renewal of their accreditation by:

- applying in writing to DEC 30–60 days before the expiry of their current term of accreditation – Applications not received within this period will not be accepted and the auditor's accreditation will automatically expire when their accreditation term ends. In this case, a new accreditation application would need to be submitted when applications are next called for.
- submitting to DEC documentation to confirm that the auditor still has access to the resources referred to in the original application for accreditation.

The *Contaminated Land Management Act 1997* sets out the grounds on which DEC may refuse to renew a site auditor's accreditation.

DEC's decision on a renewal application, including the period of any renewal, will be based principally on the results of its review of the auditor's work (see Section 2.7.1). DEC will consider whether it is satisfied with the standard of the work and whether in that work the auditor has met the requirements outlined in Sections 3 and 4 of these guidelines. DEC may also have regard to any matter that it considers relevant to the auditor's suitability for accreditation, which may extend, for example, to the auditor's conduct in carrying out other relevant professional services.

If DEC decides to renew the auditor's accreditation, the auditor must pay the accreditation fee (see Section 2.5). The auditor must also submit to DEC a copy of a current insurance certificate with a statement that the cover is sufficient to meet DEC's requirements (as outlined in Section 2.6). The policy must cover the period of accreditation and their site audit work.

Auditors will generally be given accreditation periods of longer than one year only if they satisfy DEC that they have maintained an acceptable quality of work for no less than the previous three years and have conducted enough site audits during those years to demonstrate they have maintained their understanding of relevant

technical and policy issues. In determining what is a sufficient number of audits, DEC will consider the scale, scope and complexity of the audits undertaken in the period under review.

Where the period of accreditation is to be greater than one year, DEC will still consider an auditor's insurance policy on an annual basis.

2.4 Changes in site auditors' circumstances

Site auditors must notify DEC within 14 days of any material changes in the circumstances of their employment, and of any other changes that could affect their eligibility for accreditation or their capacity to do site audits.

Such changes include:

- a change of employer
- a change in the membership of their support team
- a change in their insurance
- the commencement of legal or disciplinary proceedings against the site auditor in their capacity as a site auditor, a third party reviewer or an environmental consultant in NSW or any other jurisdiction.

As site auditors are accredited as individuals, a change of employer will not automatically affect an auditor's ongoing suitability to remain accredited. However if, for example, an auditor's support team is no longer available because the team members are staff of the auditor's previous employer, the auditor would need to satisfy DEC that he/she had an appropriate new support team.

2.5 Accreditation fee

Site auditor accreditation is subject to payment of the correct accreditation fee. The fee is prescribed in the CLM Regulation, as follows:

- Up to and including one year: \$3500
- More than one and up to and including two years: \$7000
- More than two and up to and including three years: \$10,500.

The fee for the full period of accreditation is to be paid within 30 days of the date of the notification to the auditor of their accreditation or as specified in the accreditation notice. The fee is non-refundable.

2.6 Insurance

Applicants for accreditation and accreditation renewal must satisfy DEC that they will have insurance cover in respect of any liability or claims for damages for professional negligence on their part arising out of site auditing activities under the CLM Act.

Insurance cover for not less than \$5 million with provision for reinstatement would generally be acceptable to DEC.

The insurance policy may be written on either an occurrence basis or a claims-made basis. However, for insurance written on a claims-made basis DEC would expect:

- the policy to have unlimited retroactivity
- the cover to be maintained in respect of the site auditor for a minimum of two years after the site auditor ceases to be accredited.

It is the auditor's responsibility to ensure that their insurance coverage meets the requirements of the CLM Act and these guidelines.

2.7 Quality control of the Site Auditor Scheme

DEC monitors the activities and reviews the work of site auditors on an ongoing basis to ensure that the standard of their performance is acceptable. Such routine monitoring will include reviewing site audit reports and site audit statements, examination of records held at auditor offices, discussions with auditors on audits in progress, and internal consultation. Where it is considered unacceptable, DEC may take action under the CLM Act to require improvement in particular areas of an auditor's work.

This section sets out the procedures that DEC will generally follow when, after reviewing the performance of a site auditor, it considers the auditor's performance is unacceptable. It may depart from these procedures in particular cases where it is appropriate to do so. In such cases, DEC will notify the site auditor involved of changes to the procedures.

Factors which may lead DEC to consider that a special review of an auditor's performance is warranted would include where it considers the legislation may have been breached, where the auditor is believed to have failed to adhere to guidelines, where there are perceptions of conflicts of interest, or where DEC has received complaints about an auditor's work.

2.7.1 Review of site auditors' work

When DEC is to specially review a site auditor's work after forming a view that the auditor's performance is not acceptable, the auditor will generally be notified in advance and told the nature of the review.

As part of the review, DEC will check whether the auditor has complied with the requirements for site auditors, including those described in Sections 3 and 4 of these guidelines.

In carrying out a review, or at any other time, DEC may use its powers under the CLM Act to:

- examine documents within the site auditor's files
- require the site auditor to provide a written explanation or other supporting evidence to justify the auditor's decisions and conclusions in a site audit
- request the site auditor to meet with DEC officers to discuss the conduct of the audit and the basis for the auditor's decisions and conclusions
- conduct an investigation (including collecting samples at a site and inspecting records, site conditions, and/or equipment) in relation to a site or a site audit
- make inquiries of administrators of site audit schemes operating elsewhere in Australia about an auditor's work under those schemes
- refer work done by the auditor to appropriate experts for independent review
- take any other action it deems necessary to determine the standard of the auditor's performance.

DEC may also refer site audit reports and statements to members of the accreditation panel for their information or review or to other experts if appropriate.

DEC will provide feedback to the site auditor on the review of their work to assist them to address any areas of concern and/or clarify DEC's expectations of the auditor.

2.7.2 Complaints and their resolution

If DEC receives a complaint about a site auditor's work, it may choose to review that work.

DEC will first write to the site auditor with details of the complainant's concerns and requesting the auditor to provide a written response. If the response and the outcome of any review

undertaken are acceptable to DEC, no further action will be taken. If they are not, DEC will determine the action needed to address the complainant's concerns.

In all cases, DEC will notify both the site auditor and the complainant in writing of its decision in relation to the complaint.

2.7.3 Disciplinary measures

Where a problem with an auditor's work is identified, DEC will advise the auditor of the problem and attempt to identify why it is occurring. It will also seek feedback from the auditor on how he/she intends to address the problem.

Where necessary, disciplinary action may be taken. This may include:

- placing conditions on the auditor's accreditation (see Section 2.2)
- issuing directions to the auditor
- suspending or revoking the auditor's accreditation
- not renewing the auditor's accreditation or renewing it for a shorter period than previously.

The nature of any disciplinary action will depend on the severity or significance of the issue identified and the auditor's previous performance.

2.7.4 Directions to an auditor

DEC may at any time issue directions to an auditor under the CLM Act, stating particular requirements with which the auditor must comply in conducting their site audit work.

DEC's intent in issuing these directions will generally be to focus the auditor on improving specific areas of their site audit work.

Auditors must comply with all directions issued to them under the CLM Act. Failure to do so is grounds for suspension, revocation or non-renewal of their accreditation.

2.7.5 Suspension, revocation or non-renewal of accreditation

The grounds for suspension, revocation or non-renewal of an auditor's accreditation are set out in the CLM Act.

Where DEC proposes to take such action, it will give the auditor notice in writing and invite them to make a written submission on why this action should not be taken within a reasonable specified time (usually 14 days).

On occasions it will be appropriate to suspend an auditor while DEC investigates performance issues.

3 CONDUCTING SITE AUDITS

This section outlines requirements that site auditors must comply with in undertaking site audits. In assessing auditor performance, DEC will examine whether an auditor has complied with these mandatory aspects as well as how the auditor has addressed the non-mandatory aspects.

This section also provides guidance to assist other interested parties understand the site audit process.

3.1 Obligations of site auditors

In conducting their work, site auditors owe a primary duty of care to the environment and the health, safety and welfare of the people of NSW.

When carrying out their site audits, including the preparation of site audit reports and statements, site auditors must:

- maintain a high professional standard
- exercise their professional and independent judgment, applying their knowledge and skill appropriately to each audit they undertake
- be objective
- conduct the audits at arm's length from any person who engaged them to do the audit and whose work they are reviewing in the audit
- act with due care and diligence.

At the outset of an audit commission, the auditor should make themselves aware of the circumstances which triggered the need for an audit. The auditor should also ensure the client is aware of what the site audit process entails.

The site auditor must check that all relevant legal requirements applicable to the site assessment, remediation and validation work have been complied with and are considered in the site audit. Examples of the principal requirements are set out in Appendix VI, although this list is not exhaustive. All cases of apparent non-compliance (or deficiencies of information) should be reported and discussed in the site audit report.

The site auditor must meet the following particular requirements regardless of whether the audit is statutory or non-statutory:

- (a) comply with applicable provisions of the CLM Act, regulations, environmental planning instruments, and any guidelines made or

approved by DEC under the CLM Act as in force from time to time

- (b) not have a conflict of interest in relation to the audit as defined by the CLM Act
- (c) where these guidelines allow an auditor to adopt or endorse an approach that differs from policies made or approved by DEC, exercise independent professional judgment in doing so and provide in the site audit report adequate and explicit justification for taking this course
- (d) finalise the site audit report before signing the site audit statement
- (e) provide in the site audit report a clear, logical discussion of issues covered in the site audit and clearly substantiate the rationale for the auditor's conclusions
- (f) discuss in the site audit report all issues pertinent to the actual or potential contamination of the site and all issues required by these guidelines to be raised during a site audit
- (g) state clearly why any human health and environmental issues that would normally be of concern are not of concern in the case of this audit
- (h) make every reasonable effort to identify and review all relevant data, reports and other information held by the person who commissioned the site audit, or which is readily available from other sources, that provides evidence about conditions at the site which is relevant to the audit
- (i) obtain advice from the appropriate technical support team members on issues that are outside the auditor's professional education, training or experience, and document in the site audit report where and from whom advice has been obtained
- (j) exercise independent and professional judgment in deciding whether or not they have sufficient information to make a decision about the suitability of a site or a plan or to draw any other conclusion in relation to actual or potential contamination of a site in the course of a site audit, with justification for conclusions to be given in the site audit report
- (k) make reasonable endeavours to find out whether any other audits have been commissioned in relation to the site and, if so, whether any of them were terminated and why

- (l) state in the audit report the scope and findings of any previous audits
- (m) in cases where the audit involves a review of site assessment, remediation or management work, visit the site to observe and verify, as far as is practicable, the completion of this work
- (n) undertake site audits of work carried out by several different contaminated site consultancies involving a range of contamination issues to avoid a perception that their audits lack impartiality.

3.2 Site audit process

3.2.1 Stages in site assessment and remediation

A site audit is the second in two tiers of work in the site assessment and remediation process.

The **‘first tier’ is the work of a contaminated site consultant**, generally engaged by the site owner or developer. The contaminated site consultant designs and conducts a site assessment and any necessary remediation and validation, and documents the processes and information in reports.

The **‘second tier’ is the site audit** which involves a site auditor independently and at arm’s length reviewing, for one of the audit purposes stated in the CLM Act, the consultant’s assessment, remediation and validation plans or reports. The material outcomes of a site audit are a site audit report and site audit statement.

3.2.2 Independence

The integrity and rigour of the NSW Site Auditor Scheme depends on the auditor’s critique of site assessment, remediation and validation work being carried out at arm’s length from the people who did the work.

A site auditor must be able to demonstrate that in conducting their audits they have exercised their own professional judgment and that the opinions they express in the audit documentation have been reached independently. The auditor must be able to satisfy DEC that in forming those opinions they have not been unduly influenced by the views or actions of others, particularly those who may have an interest in the outcome of the audit.

To help ensure that an audit is conducted at arm’s length, the auditor should not be engaged by the consultant whose work is to be reviewed. Such an engagement is one that might reasonably be seen

to give rise to a conflict between the site auditor's duties as a site auditor and their interests under the engagement.

Auditors must not audit first tier work if they have been involved in any aspect of that work because they would not have the necessary independence from this work.

An independent review undertaken by a consultant in his or her capacity as an accredited site auditor cannot be changed into something other than a site audit by such expedients as not issuing a site audit statement, issuing a disclaimer to the effect that 'this is not a site audit', or not complying with provisions about site audits in the CLM Act or these guidelines.

A consultant who is an accredited site auditor must ensure that their participation in any first tier work is manifestly being carried out in their capacity as a consultant. For example, any reports or correspondence produced in this work must not be signed off as an accredited site auditor for and on behalf of the consultancy.

A consultant who is also an accredited site auditor and who carries out first tier activities (for example, by being directly involved in the design, or implementation of the site assessment, its remediation or validation) is not, in carrying out those activities, conducting an independent review of the first tier work.

Site auditors as expert witnesses

The CLM Act is not intended to capture as 'site audits', situations where site auditors provide independent opinions solely for the purpose of giving evidence as expert witnesses in Court proceedings. In these circumstances, site auditors need not comply with the requirements relating to site audits in giving those opinions or that evidence. However they should, of course, exercise all due care and comply with all relevant legal requirements.

3.2.3 Conflicts of interest

The obligations of site auditors with regard to avoiding conflicts of interest are detailed in the CLM Act. In broad terms, a site auditor must not carry out a site audit of land:

- (a) if he or she is, or is related to, a person by whom any part of the land is owned or occupied
- (b) if he or she has a pecuniary interest in any part of the land or any activity carried out on any part of the land
- (c) if it involves the site auditor reviewing any aspect of work carried out by, or a report written by, the site auditor or a person to whom the site auditor is related.

The categories of persons that are considered to be related to the site auditor and the tests for pecuniary interest are set out in the CLM Act.

The responsibility to ensure that there is no conflict of interest rests with the auditor. If an auditor is uncertain whether there is a conflict, they should seek independent legal advice. DEC cannot provide that advice.

3.2.4 Scope of a site audit

Depending on its purpose, a site audit determines whether, in the auditor's opinion, the consultant's work complied with relevant procedures and guidelines, whether it provides a robust basis for decisions or actions relating to the land concerned and/or whether the land is suitable for particular uses.

While a site audit must be for one or more of the purposes referred to in the CLM Act, the precise scope of work involved in the audit is usually defined by a site owner or developer. They may wish to know the current condition of the land for which they are contemplating a change in use, require an independent review of plans for assessment, investigation and/or remediation of the site, or need to know if remediation work has been completed to the level required for a particular land-use category. In some situations, local planning authorities may define or contribute to, the scope of the site audit, particularly where the outcome of the audit is intended to be used to support the development consent process.

A site audit may include, but is not limited to, review of:

- the site's history of contaminating or potentially contaminating activities
- planning of the sampling and analysis program
- sample collection and sample transport procedures
- quality control and quality assurance procedures
- chemical analyses of site samples
- impacts of chemicals and chemical mixtures on human health and the environment
- potential for off-site migration of contamination
- data collection, evaluation and interpretation
- mathematical modelling
- assessment of risk
- remedial action plans

- validation and monitoring
- conclusions and recommendations.

3.2.5 Procedures for statutory and non-statutory site audits

The meaning of statutory and non-statutory audits is given in Section 1.5.

Statutory site audits

For statutory site audits, a site auditor must carry out the following steps in the order indicated:

1. Notify DEC in writing within seven days of being commissioned by any person to carry out a site audit, specifying the name of the person and the location of the land concerned.
2. Prepare and finalise a site audit report.
3. After finalising the report, prepare a site audit statement using the form approved by DEC.
4. Issue the site audit report and statement to the person who commissioned the site audit.
5. Provide a copy of the site audit statement to DEC and the local authority at the same time as it is issued to the person who commissioned the site audit.
6. Submit the details of the site audit in the auditor's annual return (see Section 3.9).

Non-statutory site audits

For non-statutory site audits, steps 2–4 and 6 (above) must be followed and in the same order.

3.2.6 Role of support team

The role of the auditor's support team is limited to providing advice to the auditor in areas relating to the team member's expertise.

The auditor is personally responsible for undertaking the site audit and making the final decision about the audit conclusions. The auditor must critically assess the information provided by the support team when forming that decision and preparing the site audit report and site audit statement. The advice of team members should be acknowledged in the audit report.

3.3 Site audit report

The site audit report must be a critical review of the information gathered by consultants during the site assessment and remediation process. The site audit report must clearly set out the rationale for the auditor's findings and any conclusions that will be contained in the site audit statement. The site audit report must not be a narrative summary of the work conducted by the consultants.

The site auditor must as far as practicable, ensure that the report is a self-contained document which requires little or no direct reference by the reader to other material or documents to support the audit findings or the conclusions contained in the site audit statement.

In particular, the auditor must include in the report all of the following information or a clear and reasonable rationale for not doing so:

- (a) site location details, including maps giving details of potential receptors
- (b) site history, describing all potentially contaminating activities
- (c) a clear outline of the actual or potential contamination of the land
- (d) potential contaminants of concern from both on-site and off-site sources, listing each specific contaminant – where the auditor considers that a contaminant that would usually be expected to be of concern is not in this case, the auditor must state this and give reasons for this conclusion
- (e) soil stratigraphy and hydrogeology
- (f) a clear statement of the investigation and remediation that has taken place
- (g) evaluation of quality assurance and quality control plans, including appropriate implementation of sampling plan(s), sample handling, collection and transport processes
- (h) analytical results and an evaluation of those results
- (i) a summary of environmental quality criteria used by the auditor in assessing the reports of consultants
- (j) assessment of risks to human health, structures and the environment arising from the actual or potential contamination of land
- (k) the need for any ongoing management of residual contamination and how that management should be achieved

- (l) requirements imposed by the planning consent authority, DEC or any other public authority and documented evidence that these requirements have been met
- (m) any evidence of, or potential for, migration of contaminants from the site including odour, air quality, stormwater, sedimentation and groundwater issues – where the auditor considers that off-site migration is not a potential issue, the auditor must say this and give reasons for this conclusion
- (n) an assessment of aesthetic issues, odours and background soil concentrations where these are required by these guidelines or other guidelines made or approved by DEC
- (o) conclusions and recommendations, and details of how they have been reached
- (p) any other information relevant to the site audit, including copies of correspondence between the auditor and consultant(s) relevant to the outcome of the assessment, remediation and validation works
- (q) the auditor's opinion of the adequacy of the work of each consultant in relation to all of the above areas
- (r) documentation of all cases where the consultants have departed from applicable guidelines with appropriate comment on whether these departures are acceptable.

If requested by DEC, the site auditor must promptly submit a copy of the site audit report to DEC, together with any other related information requested by DEC.

A planning authority may also request a copy of the site audit report to assist it in decision-making or determine factual information that needs to be recorded for planning purposes.

The site auditor must prepare and finalise the site audit report before issuing the site audit statement.

3.4 Site audit statements

3.4.1 Preparing a site audit statement

The site auditor must prepare and issue a site audit statement which is consistent with the scope of the site audit which he or she was commissioned to do. For example, if the commission was solely to review whether a remedial action plan was appropriate for its purpose, the conclusions in the site audit statement must be limited to that review.

The auditor must prepare the statement on the form approved by DEC at the time the statement is issued. This form is available on DEC's website at www.environment.nsw.gov.au/clm/auditorscheme.htm. The wording on the approved form must not be altered except as permitted by the instructions on the form.

To assist in describing the area which is the subject of the audit, a current map or survey plan clearly depicting the area may be attached to the site audit statement provided it is in a format that can be readily used by a planning authority and is capable of clear black and white reproduction.

If contamination is to remain on the site in a discrete area, such as in a containment cell, a surveyed plan showing the area concerned should be attached to the site audit statement.

3.4.2 Signing and issuing site audit statements

When signing a site audit statement, auditors are certifying that they have personally completed a site audit and have examined and are familiar with the information contained in the statement and all reports and other information referred to in the statement or report.

A site auditor must not sign a site audit statement on behalf of another auditor.

The site auditor must give a signed copy of the completed site audit statement to the person who commissioned the site audit.

For **statutory** site audits only, the auditor must also give a copy of the site audit statement to DEC and the local authority at the same time it is issued to the person who commissioned it.

The auditor must assign each site audit statement its own consecutive number and keep a copy of each statement.

3.4.3 Finality of site audit statements

The site auditor must not change or withdraw the site audit statement after they have signed it. It is therefore crucial that site auditors ensure the accuracy of all information contained in the site audit statement before signing it.

Should errors be found after the site audit statement has been signed, the site auditor must send a corrected version of the statement to the person who commissioned the site audit. The same site audit statement number must be retained but suffixed or prefixed with an 'R' to indicate that this is a revised statement. If it is a **statutory** site audit, copies of the revised statement must also be sent to DEC and

the local authority, within 14 days of signing, with a letter specifying what the amendments were.

Errors which may be corrected in this manner include changes which do not affect the auditor's conclusions such as typographical or formatting changes or amended property descriptors.

Further remediation after a site audit statement has been issued

In some cases after a site audit statement which certifies that a site is suitable for a particular use has been issued, further remedial work is undertaken on the site to allow a more sensitive use. A new site audit may be necessary if the planning authority requires confirmation that the new land use is suitable.

3.4.4 Significant new findings

After a site audit statement has been issued, the site auditor may become aware of new information about contamination at the site that may materially affect the validity or appropriateness of the conclusions in the site audit statement or report. Such circumstances may arise, for instance, where formerly unknown and unrecorded site history information becomes available after the statement is issued. The auditor must promptly notify the client and, where the audit is statutory, DEC and the local authority.

Where an auditor is commissioned to do so, they must issue a revised site audit report and/or statement (as appropriate) to take account of this new information and issue the revised version to the client (with a different number from the original). If it was a **statutory** site audit the auditor must also send the revised site audit statement to DEC and the local authority.

The auditor must not issue the revised site audit report and/or statement without first providing to DEC written justification for issuing a revised document and receiving DEC's written approval to do so.

3.4.5 Conditions included in site audit statements

Site audit statements must be issued with as few conditions as practicable, since these qualify the auditor's conclusions, and therefore detract from the definitive nature of the statement.

However, there will be some occasions when it will be appropriate for a site audit statement to contain conditions, such as a condition requiring the implementation of an environmental management plan (EMP) (see Section 3.4.6).

Where the site audit statement states that future assessment or remediation of the site is required – for example, if development is proposed on an area where contaminated soils were contained – it must also state whether the assessment or remediation should be audited by an accredited site auditor.

Where the site audit is being done as part of the planning approval process under the *Environmental Planning and Assessment Act 1979*, the method for ensuring compliance with any condition must be discussed by the auditor with the consent authority, and agreed to by the authority prior to the audit's completion.

Where compliance with a condition could only be ensured with the involvement of an authority, auditors must seek written approval from the relevant authority before issuing a site audit statement with that condition. For example, auditors must have written approval from DEC or a local council before issuing conditions that involve DEC or the local council, respectively.

Any conditions that are included in the site audit statement must also be able to be complied with by lawful means.

3.4.6 Environmental management plans

Within the context of contaminated sites management, an environmental management plan (EMP, sometimes also called a 'site management plan') means a plan which addresses the integration of environmental mitigation and monitoring measures for soil and groundwater throughout an existing or proposed land use. An EMP succinctly describes the nature and location of contamination remaining on-site and states what the objectives of the plan are, how contaminants will be managed, who will be responsible for the plan's implementation and over what time frame actions specified in the plan will take place.

An EMP can be an effective means of ensuring the environment is protected, users of the site are not exposed to contamination remaining on-site and the site remains suitable for the specified use when:

- complete clean-up of contamination affecting an area is not practicable (for example low levels of contamination under a concrete slab)
- contaminants are being capped or contained on-site
- remediation is likely to cause a greater adverse impact than would occur if the site were left undisturbed.

The length and precise content of the EMP will depend on the complexity of site issues. However a short, concise EMP may be adequate to address issues at a simple site. Regardless of its length, an EMP must be a stand-alone document with enough detail and clarity in the description of the site and the actions required to be readily understood. Generally, EMPs should be prepared by an environmental consultant for review by the site auditor, rather than by the site auditor. However, where the requirements of an EMP are of a minor nature, it may be acceptable for the site auditor to prepare it.

Implementation of an EMP must not be included by a site auditor as a condition on a site audit statement nor accepted by the auditor as a means of managing contamination of a site unless the following conditions have been met.

- (a) The EMP has been reviewed by the auditor.
- (b) The EMP can reasonably be made to be legally enforceable, for example because compliance with it is a requirement of a notice under the CLM Act or of development consent conditions issued by the relevant planning authority. The relevant authority (DEC or the local council in these cases, respectively) should be asked their view on the legality of the draft EMP.
- (c) There will be appropriate public notification of any restrictions applying to the land to ensure that potential purchasers or other interested individuals are aware of the restrictions, for example appropriate notations on a planning certificate issued under section 149(2) of the *Environmental Planning and Assessment Act 1979* or a covenant registered on the title to land under section 88B of the *Conveyancing Act 1919*.
- (d) There is no off-site migration of contamination from the site which is the subject of the site audit or, where there is off-site migration or its potential, that contamination within the site is managed or monitored so that it does not present an unacceptable risk to either the on-site or off-site environments.

3.5 Finalising audit statements

3.5.1 Site audit statement findings

Site auditors must ensure that their finding that a site is suitable for a particular use does not assume or depend on the completion of unfinished remediation work to make the land suitable for that use.

Before a site auditor certifies a site can be made suitable if remediated in accordance with a specified plan, they must be satisfied that:

- the plan takes into account the particular conditions of that site, that is it is not a generic 'off the shelf' plan
- it is feasible to implement the plan at the site at some time.

3.5.2 Unsatisfactory assessment, remediation or validation

Where an auditor is not satisfied with the assessment, remediation or validation of a site, or considers that the site is not suitable for the proposed land use, the auditor must discuss this with the person who commissioned the audit, before issuing the site audit statement. Where appropriate, the auditor should suggest further work that would satisfy them that the site is suitable for the proposed use. Alternatively, the auditor may suggest the development of the site for a less sensitive use.

If the site auditor decides to issue the site audit statement without further work being done, they must certify that the site is not suitable for its proposed use.

3.6 Progressive development of a site

3.6.1 Development of a site in sections or stages

Where a site is to be developed progressively, section by section, discrete site audits may be required in relation to each section. As each section is developed, the site auditor may issue a site audit statement concerning the suitability of that section for the proposed land use. The land parcel subject to the audit must be clearly identified in the site audit statement in an appropriate format for use by a planning authority, for example as a separate lot in a deposited plan, or – where it is part of a lot – depicted on a current map or survey plan attached to the statement.

The site auditor must consider the compatibility of land uses during staged developments and take reasonable steps to ensure that sections that have been certified as suitable for a proposed use are not re-contaminated by ongoing site works or adjacent contamination.

3.6.2 Multi-stage audits

If a site auditor is commissioned to undertake a single site audit involving a lengthy, multi-stage or multi-purpose review, the auditor

must issue a site audit statement only when the process is completed. An example would be an audit involving reviews of the adequacy of firstly the site investigation, then the remediation, followed by the validation leading to a statement about the suitability of the land use.

However the auditor may provide written interim advice on the work plans or reports in the lead-up to issuing the final site audit statement at the end of the entire audit.

When this interim advice is provided, the site auditor must:

- specify that the interim advice does not constitute a site audit report or statement
- ensure the interim advice is consistent with DEC guidelines and policy
- not pre-empt the conclusion to be drawn at the end of the site audit process
- clarify that a site audit statement will be issued at the end of the audit process
- document in the site audit report all interim advice that was given.

However, if the auditor is expressly commissioned to provide a series of site audits for certain discrete, designated stages of a project, the auditor should issue a separate site audit statement for each of those audits.

3.7 Other considerations for auditors

3.7.1 Change of site auditor

If a site auditor is unable to proceed with or finalise an audit and another site auditor is appointed, the new auditor must undertake a full audit in relation to the site concerned. The new auditor should comment on the circumstances surrounding the change of auditor in the site audit report if it has a material bearing on the audit.

The new site auditor may refer to the work of the previous auditor. However, they must not defer to the previous auditor's judgment on any of the matters required to be considered in undertaking the audit. The new auditor must exercise their own professional judgment and make their own independent decisions about all matters that form part of the site audit report and site audit statement.

3.7.2 False audits or information

Under the CLM Act it is an offence for a person to make any statement, either in connection with a site audit or a site audit

statement, that the person knows is false or misleading in a material respect. The maximum penalty for the offence for an individual is 600 penalty units or imprisonment for two years or both, and for a body corporate 1250 penalty units.

3.7.3 Falsely claiming to be a site auditor

It is an offence under the CLM Act for an individual to represent themselves as a site auditor accredited under the CLM Act when they are not, including while their accreditation is under suspension, or to conduct types of site audits which they are prohibited from conducting as a condition of their accreditation. It is also an offence for an auditor to allow someone else to make this sort of representation about them.

It is an offence for a body corporate to represent itself, or allow others to represent it, as an accredited site auditor.

The maximum penalty for these offences for an individual is 600 penalty units and for a body corporate 1250 penalty units.

3.8 Communications with DEC

3.8.1 Significant health or environmental problems posed by the site

Site auditors should bring to the attention of DEC any significant environmental or public health problem that the auditor considers is posed by a site being audited, as soon as practicable after the auditor becomes aware of the problem.

3.8.2 Premature cessation of a statutory site audit

If, after commencing a statutory site audit, the site auditor permanently stops working on the audit for any reason (for example, because they have been directed to cease work by the person who commissioned the audit), the auditor must provide DEC with the following information in writing:

- the number of the auditor's notification to DEC
- the site details
- the details of the person who commissioned the site audit (name, address, phone number)
- the reason for the audit being stopped
- the date on which the audit was stopped.

The auditor should also send this information to the relevant local authority.

3.9 Auditors' returns

Once a year site auditors are required to provide DEC with details of all completed statutory and non-statutory audits, as well as those in progress. The CLM Regulation currently requires this annual return covering audit activity between March of one year and the end of February the next year to be furnished by 31 March. For newly accredited auditors, it runs from the date of accreditation to the end of February. Any changes to the reporting dates in the Regulation will be notified to auditors.

In their annual return, an auditor must provide the following information for each site as prescribed by the CLM Regulation:

- the location of the site, including lot and DP numbers, street address, suburb and local government area
- the size of the site
- the site's zoning under the *Environmental Planning and Assessment Act 1979* and, if a change in zoning is proposed, its proposed zoning
- the date when the auditor was commissioned to conduct the site audit
- the date the site audit commenced
- the date by which the site audit was completed or is expected to be completed
- the land use(s) of the site that have caused the contamination for which remedial action was carried out
- the current land use of the site and any proposed land use
- the conclusions of the site audit about the suitability of the site for the current and proposed land uses
- the name of the person who did, or is doing, the remedial work that has been reviewed, or is being reviewed, and the titles of any of their reports that have been reviewed or are being reviewed.

3.10 Auditor meetings

DEC holds meetings with auditors as required. Auditors are given written notice of these meetings. Attendance is highly recommended. An auditor's record of attendance is taken into account when considering whether to re-accredit an auditor.

4 CONTAMINATION ASSESSMENT, REMEDIATION AND MANAGEMENT

This section outlines some of DEC's policies in relation to the assessment and remediation of contaminated sites and the management of any contamination remaining on-site. The policies are relevant to auditors' decision-making about (among other things):

- the quality of the data used in the assessment of contamination
- issues encountered in the investigation of contamination
- remediation activities
- land-use suitability.

Site auditors must be able to demonstrate to DEC's satisfaction that they have complied with the requirements in this section.

Where these guidelines state that a site auditor must 'check' something, for example an aspect of a consultant's work, it is also a requirement that they:

- state in the site audit report whether or not this checking has been done
- are able to provide evidence of such checking by, for instance, referring to sources
- document in the site audit report any instances where a consultant's work departs from policies or guidelines made or endorsed by DEC, together with their reasons for accepting such departures.

4.1 Assessing quality assurance and quality control (QA/QC)

In the course of a site audit, an auditor must ensure that the data from the site assessment is reliable and representative of the condition of the site. To achieve this objective, site auditors must check the reliability and fitness for purposes of both field sampling procedures and laboratory programs.

Appendix V contains the essential issues which must be included in the quality assurance program conducted by the contaminated site consultant during site assessment and remediation processes.

4.2 Assessment of site contamination

4.2.1 Soil investigation levels

The decision-making process for assessing urban sites (Appendix I) aims to help site auditors satisfy themselves that soil investigation

levels (SILs) shown in Appendix II have been used appropriately by contaminated site consultants to assess concentrations of contaminants in soil. SILs are the soil concentration levels above which further investigation and evaluation are required. SILs do not take account of all possible environmental impacts, but they are intended as a practical response to contaminated site issues dealt with in the NSW urban environment. SILs include health-based investigation levels and provisional phytotoxicity-based investigation levels.

SILs do not:

- apply to land being, or proposed to be, used for agricultural purposes (consult NSW Agriculture and NSW Health for the appropriate criteria for agricultural land)
- take into account all environmental concerns, such as the potential effects on wildlife (where relevant, these would require consideration against different criteria).

The **health-based investigation levels** (HILs) shown in Appendix II and the exposure scenarios on which they are based are published in the *National Environment Protection (Assessment of Site Contamination) Measure 1999* (the NEPM) and also in the *enHealth Monographs—Soil Series*:

- *Health-based Soil Investigation Levels* (Imray & Langley 2001)
- *Exposure Scenarios and Exposure Settings* (Taylor & Langley 2001).

Site auditors should refer to these papers for information about the development of the HILs.

The phytotoxicity (toxicity to plants) of contaminants is used as the indicative environmental effect to be considered in the context of urban redevelopment. The provisional **phytotoxicity-based investigation levels** (PILs) proposed in the NEPM are single-number criteria. They should be compared against individual data points rather than contaminant concentrations averaged across a site.

These criteria are intended to be used as a screening guide. They do have significant limitations because phytotoxicity depends on soil and species parameters in ways that are not fully understood. If the soil is not sandy loam or in the pH range 6–8, other tests need to be undertaken to determine appropriate PILs. If ecotoxicity tests of site soils for plant species relevant to the proposed use of the land concerned have been undertaken, site auditors must check that the limitations of these tests have been addressed by the consultant.

The decision-making process flowchart in Appendix I describes how HILs and PILs must be applied to different proposed land uses.

Assessment of imported fill

HILs and PILs are not appropriate criteria for assessing fill material that has been, or will be, imported to a site. Auditors must check that HILs and PILs have not been used for this purpose by consultants. Sections 4.1.1 and 4.1.2 of the *Sampling Design Guidelines* (EPA 1995b) provide advice on the validation of imported fill.

4.2.2 Risk assessments

A site-specific risk assessment may have been undertaken by the contaminated site consultant where SILs are not available for particular contaminants, or assessment of contaminants against SILs at a particular site is inconclusive. The auditor must check whether the risk assessment is in accordance with the NEPM and any relevant guidelines made or approved by DEC. The auditor must also check that any human health risk assessment satisfies all the requirements in the checklist in Appendix VII.

The auditor must check that all site-specific risk assessments are scientifically valid and that the site-specific criteria recommended by the consultant are appropriate to protect public health and the environment.

4.2.3 Petroleum hydrocarbons

Currently, there are no nationally endorsed human health-based investigation levels or DEC provisional phytotoxicity-based investigation levels for volatile petroleum hydrocarbons. In the interim, and subject to the case discussed below for applying NEPM criteria, site auditors must apply, without multiplication, the criteria listed in the *Guidelines for Assessing Service Station Sites* (EPA 1994) to all land uses in their assessment of consultants' work.

Auditors may apply the NEPM criteria for semi-volatile TPH fractions (C_{16} – C_{35} and $> C_{35}$) for soil, but they must not apply the NEPM health-based criteria unless the laboratory analysis can unequivocally differentiate between aromatic and aliphatic compounds. If this cannot be done, the C_{10} – C_{40} criteria in the service station guidelines must be applied by auditors as above.

Criteria based on aesthetic considerations cannot be used as surrogates for investigation levels. The criterion of 10 mg/L for oil and grease in the explanatory notes of Table 4 of the service station guidelines is based on aesthetic (visual) issues. It is not an appropriate assessment criterion for TPHs as this criterion cannot be translated into carbon fraction ranges of TPHs, e.g. C_{10} – C_{36} .

4.2.4 Off-site migration of contamination

Site auditors must consider the potential for contamination to migrate from the site which is the subject of the site audit. The auditor must discuss in the site audit report evidence for the occurrence of off-site migration of contaminants and give an opinion on the impacts on likely receptors. If the auditor believes the off-site migration of contamination should be addressed to protect human health or the environment, the auditor must state this explicitly in the site audit report and in the 'comments' section of the site audit statement.

Auditors should also be aware of the potential for off-site impacts, such as air quality, odour and aesthetics, in considering the appropriateness of remediation or the suitability of a site for a specified use.

The site auditor must take all reasonable steps to advise the site owner or occupier of any potential risk of off-site migration and draw their attention to the circumstances where they may have obligations under the CLM Act.

4.2.5 Assessing groundwater

Groundwater assessment criteria

Site auditors must check that the potential for groundwater contamination has been adequately assessed. This includes checking that the relevant groundwater assessment criteria have been appropriately applied and discussed in the consultant's report in accordance with relevant guidelines approved by DEC including:

- Schedule B (6) of the *National Environment Protection (Assessment of Site Contamination) Measure* (NEPC 1999)
- the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC & ARMCANZ 2000) and updates
- *Guidelines for Drinking Water Quality in Australia* (NHMRC & NRMCC 2004)
- future guidance on assessing and managing groundwater contamination which is made or endorsed by DEC after publication of these guidelines.

The site auditor must state in the site audit report whether or not the most appropriate groundwater assessment criteria have been applied. If they have not, the auditor must state the reasons why this is acceptable.

Plume delineation

If groundwater contamination is identified, the site auditor must check that the lateral and vertical extent of the contaminant plume have been adequately delineated. Where they have not, this must be noted by the auditor in the site audit report.

Separate phase contaminants

Site auditors must ensure that the presence of separate phase contaminants has been adequately investigated where it is possible that separate phase may be present.

Where a site auditor concludes that separate phase contaminants are present at a site and/or there is potential for off-site migration of contaminants at a site, the auditor should take reasonable steps to bring this to the attention of the person who commissioned the site audit and indicate any potential obligation under the CLM Act to report certain contamination to DEC. Any written responses to the auditor from the person concerned should be appended to the site audit report.

4.2.6 Assessing sediment quality

Guidance for assessing contamination of sediments is contained in the sediment quality guidelines in the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC & ARMCANZ 2000). Where assessment of sediments has been undertaken, site auditors must check that the consultant has applied these guidelines.

4.2.7 Aesthetic issues

The auditor must check that aesthetic issues have been considered in the assessment of contamination. Aesthetic issues include the generation of odours from the site and any discolouration of the soil as a result of contamination.

While the decision-making process for assessing urban sites (Appendix I) requires that contamination assessments address aesthetic issues, this does not extend to consideration of discolouration on commercial or industrial sites.

4.3 Remediation of contamination

4.3.1 General considerations

A site auditor must be satisfied that any proposed or completed remediation is technically feasible, environmentally justifiable and consistent with relevant laws, policies and guidelines. Where an

auditor is satisfied of these matters, they must document the reasoning in the site audit report.

In reviewing remediation strategies proposed by the consultant or remediation actions already taken, site auditors must have regard to:

- national and NSW remediation policies
- the *Protection of the Environment Operations Act 1997* and Regulations
- other legislation such as the *Environmentally Hazardous Chemicals Act 1985* and the *Environmental Planning and Assessment Act 1979*
- relevant technical guidance documents issued by DEC.

4.3.2 Site remediation policy

The policy of the then Australian and New Zealand Environment and Conservation Council (ANZECC) and the National Health and Medical Research Council (NHMRC) on remediation of contaminated sites is published in the *Australian and New Zealand Guidelines for the Assessment and Management of Contaminated Sites* (ANZECC & NHMRC 1992) and is followed in NSW.

This means that soil remediation and management is implemented in the following preferred order:

1. on-site treatment of the soil so that the contaminant is either destroyed or the associated hazard is reduced to an acceptable level
2. off-site treatment of excavated soil so that the contaminant is either destroyed or the associated hazard is reduced to an acceptable level, after which the soil is returned to the site
3. removal of contaminated soil to an approved site or facility, followed where necessary by replacement with clean fill
4. consolidation and isolation of the soil on-site by containment within a properly designed barrier.

If remediation is likely to cause a greater adverse effect than leaving the site undisturbed, remediation should not proceed.

In cases where it is not viable to remediate large quantities of soil with low levels of contamination, alternative strategies should be considered or developed.

The appropriateness of any particular option will depend on a range of local factors. Where a site auditor supports, in the site audit report, any specific remediation option or options proposed by the consultant, they must clearly justify the reasons for their support in

terms of relative advantages, as well as the reasons for the rejection of particular options.

4.3.3 On-site containment and capping

Site auditors must, where relevant, demonstrate in their site audit reports that they have considered the technical issues associated with on-site capping or the use of other physical barriers to contain contamination.

Such options should be considered only where other preferred approaches from the ANZECC and NHMRC remediation hierarchy, outlined in Section 4.3.2 and followed in NSW, are not applicable.

The capping and/or containment strategy must be appropriate for the contaminants of concern. Before endorsing any capping and/or containment proposal site auditors must check that it:

- maximises the long-term stability of the capping and/or containment system(s) and any proposed structures above it (from an engineering perspective) and, where applicable, minimises the potential for leachate formation and/or volatilisation
- does not include the erection of structures on the capped and/or contained area that may result in a risk of harm to public health or the environment
- recommends a notification mechanism to ensure that the capped and/or contained areas are protected from any unintentional or uncontrolled disturbance that could breach the integrity of the physical barrier, such as recommending placing a notation or covenant on the property title or a notation on a s.149 certificate or issuing a notice or placing a covenant on the title to land under the CLM Act to require maintenance of remediation action under the Act.

Refer also to Sections 3.4.5 and 3.4.6 regarding conditions placed on site audit statements and reliance on environmental management plans.

4.3.4 Contamination at depth

As a general principle, contamination at a site must be remediated to meet the appropriate clean-up criteria.

Clean-up criteria for contaminated soils at depth may differ from the criteria for shallow soils due to differences in exposure opportunities. However, the inhalation of volatile contaminants and the need to protect groundwater require consideration, irrespective of depth. Where clean-up criteria for contaminated soils at depth are

different from those for shallower soils, an auditor must consider, in the site audit report, the need for any ongoing management of the contamination at depth in addition to any requirements for managing shallow soil contamination. An auditor must document in their report the rationale supporting the conclusion on this issue.

Irrespective of the depth of contamination, an auditor must not endorse any proposal to leave contamination which may pose an unacceptable human health or environmental risk *in situ* unless they have first checked that the following issues are satisfactorily addressed:

- investigation has demonstrated that the remaining contamination will not affect the groundwater quality and that any contaminant vapours will not migrate to the surface and pose a risk to human health
- an environmental management plan has been developed, will be implemented, and can be enforced under relevant laws to ensure that, if the contaminated soil is disturbed, it will be handled in an appropriate manner to avoid any increase in potential risks to human health or the environment
- the local planning authority is notified that contamination remains at depth on the site, together with its location, nature and extent, details of the environmental management plan and any other regulatory requirements that relate to the contamination, thus allowing the local authority to record this information, as it considers appropriate, in its property information system for the site, such as s.149 certificates.

4.3.5 Vertical mixing or other mixing techniques

The technique of mechanically mixing the contaminated surface soil with cleaner soil found at greater depths ('vertical mixing') has been developed for use on broad-acre agricultural land where there is no readily available or economically feasible method available for remediating large quantities of soil with low levels of contamination.

Vertical mixing must only be carried out where **all** prerequisites listed in the *Guidelines for the Vertical Mixing of Soil on Former Broad-acre Agricultural Land* (EPA 1995a) are satisfied.

Where such mixing is proposed as a remedial strategy in contexts other than broad-acre agricultural land, the site auditor must not endorse the proposal unless they have first checked that DEC agrees with the proposal and the pre-requisites outlined in the vertical mixing guidelines have been met.

4.3.6 Bioremediation

Where relevant, site auditors must demonstrate in their site audit reports an awareness of the issues associated with the introduction of imported organisms for bioremediation. DEC encourages the use of local species in bioremediation because this eliminates the risks associated with introducing foreign living organisms to the environment. However, where imported organisms are used, a site auditor must not endorse the use of those organisms unless they are satisfied that:

- for species imported from overseas, details of the relevant Australian Quarantine Inspection Services permit, including any conditions accompanying the permit, are contained in the consultant's report
- a certificate from a recognised laboratory identifying the species to be released is contained in the report
- an assessment of the human and animal health risks arising from the use of the imported organisms has been made and is presented in the report, and these risks are acceptable
- the distribution of the organisms in Australia and the dispersal mechanisms in air, water and soil are known
- the expected survival period of the organisms in the environment and the possible consequences of the release have been assessed and are acceptable
- an estimate of the number of organisms to be released and the frequency of release has been documented
- the survival of the organism in the environment has been monitored by appropriate methodologies
- contingency measures are in place to remove or destroy the organisms if a hazard becomes evident during the course of the release.

4.3.7 Contaminated wastes

When reviewing proposals or reports relating to the management of contaminated wastes, site auditors must have regard to the provisions of the NSW Government's framework for managing wastes, including:

- the *Protection of the Environment Operations Act 1997*
- the Protection of the Environment Operations (Waste) Regulation 1996, which contains provisions relating to the management of wastes (such as transportation, treatment and processing)

- *Environmental Guidelines: Assessment, Classification and Management of Liquid and Non-liquid Wastes* (EPA 1999), as revised from time to time
- the *Waste Avoidance and Resource Recovery Act 2001* which establishes the following hierarchy for the management of resources:
 - avoid unnecessary resource consumption
 - recover resources (including reusing, reprocessing, recycling and recovering energy)
 - disposal (as a last resort).

4.3.8 Chemicals and wastes controlled by chemical control orders

The chemicals and declared chemical wastes controlled in NSW by chemical control orders (CCOs) issued by DEC under the *Environmentally Hazardous Chemicals Act 1985* are listed in Table 1.

CCOs set out requirements for manufacturing, keeping, using, processing, storing, selling, transporting or disposing of chemicals and declared chemical wastes.

Table 1: Chemicals and declared chemical wastes controlled by chemical control orders in NSW

Chemical or declared chemical waste	Chemical control order
Aluminium smelter wastes	Chemical Control Order in Relation to Aluminium Smelter Wastes Containing Fluoride and/or Cyanide 1986
Dioxin-contaminated wastes	Chemical Control Order in Relation to Dioxin-contaminated Wastes 1986
Organotin wastes	Organotin Waste Materials Chemical Control Order 1989
Polychlorinated biphenyls (PCBs) and PCB wastes	PCB Chemical Control Order 1997
Scheduled chemical wastes (pertaining to certain chlorinated chemicals)	Scheduled Chemical Wastes Chemical Control Order 2004

Site auditors should be aware that CCOs may be revised by DEC as part of the implementation of national management plans, and auditors must check that the requirements of the current version of the CCO have been complied with in a consultant’s remediation strategy.

A site auditor must not endorse a management strategy proposed for a site which involves chemicals or chemical wastes subject to a CCO, unless they are satisfied it complies with the requirements set down in the CCO. For example, certain chemicals occurring above the prescribed concentrations are prohibited from being disposed of at any landfill.

There is a program of national management plans for Schedule X wastes (ANZECC 1994). Schedule X wastes are those associated with:

- hexachlorobenzene (HCB) (ANZECC 1996a)
- polychlorinated biphenyls (PCBs) (ANZECC 1996b)
- organochlorine pesticides (OCPs) (ANZECC 1999).

The national management plans set time lines for the destruction and disposal of Schedule X wastes. The relevant authorities implement the regulatory aspects of those plans.

4.3.9 Asbestos and asbestos waste

There are currently no national or DEC-endorsed guidelines relating to human health or environmental investigation of material containing asbestos on sites.

Until such guidelines become available, auditors must exercise their professional judgment when assessing whether a site is suitable for a specific use in the light of evidence that asbestos may be a contaminant of concern. NSW Health will provide advice to auditors on this subject on a case-by-case basis where appropriate.

There are particular requirements for asbestos waste in the Protection of the Environment Operations (Waste) Regulation 1996. Auditors must check that documentation is produced for the disposal of asbestos at appropriate waste facilities in accordance with the Regulation. The Asbestos Wastes Chemical Control Order 1989 has been repealed.

4.3.10 Unexploded ordnance

A site containing unexploded ordnance (UXO) represents a safety hazard and must only be assessed by someone qualified to manage UXO safely. Where it is not within an auditor's area of expertise to assess whether a site is safe or whether there has been an appropriate level of site investigation, an auditor must obtain advice from someone qualified to draw conclusions on the presence of UXO or future likelihood of finding it on the site.

Where an auditor suspects that a site may contain ordnance, they should be satisfied that appropriate searches have been undertaken to ensure that the site's history has been adequately assessed. The Land Titles Office holds records of lands affected by military activities. These records must be searched before the Department of Defence will provide additional details about the site.

The Department of Defence is able to advise on suitably qualified experts who can assess the presence of UXO on the site. The expert should also be able to assess the risk of future finds and develop a management plan for addressing any risks associated with them.

4.3.II Groundwater clean-up and management

Source removal

Site auditors must check that all primary sources of groundwater contamination, such as leaking infrastructure, and secondary sources, such as non-aqueous phase liquids and adsorbed phase product, have been removed or otherwise addressed appropriately.

If a source cannot be removed, the auditor must clearly state in the site audit report the reasons why and also the implications that this has for groundwater quality.

Impacts of groundwater contamination

If groundwater beneath a site is contaminated, the site auditor should ensure that the investigation and remediation reports have adequately considered:

- the nature and extent of contamination including:
 - the toxicity effects of the contaminants
 - all potential contaminant transport pathways
 - all potential biotic and abiotic receptors
- the risks which the contamination may be posing to human health and the environment.

If the auditor concludes that groundwater contamination may be having an impact on human health or the environment by moving off-site:

- this should be specifically discussed in the site audit report and noted on the site audit statement
- the auditor must take reasonable steps clearly and in writing to advise the person who commissioned the site audit of the duty of site owners and polluters to notify DEC of contamination under the CLM Act.

If a proposal to remediate groundwater is reviewed as part of a site audit, in the site audit report the auditor should comment on:

- the adequacy of the data available to support the proposed remedial design
- whether the remediation proposal has examined in detail the adequacy and practicability of other remedial options, not just the preferred option
- the technical feasibility of the proposed remediation in being able to meet the remediation objectives
- the likely time frame for remediation
- the monitoring requirements
- validation requirements.

Monitored natural attenuation (MNA)

DEC's policy is that a natural attenuation proposal must be accompanied by an appropriate monitoring program. MNA should only be considered as a remediation methodology where the following conditions are met:

- the source of the contamination has been removed as far as practicable
- the lateral and vertical extent of the contamination has been defined
- the site and hydrogeology have been adequately characterised, and there is clear evidence that attenuation rates are sufficient to achieve the remedial goals at the site within a reasonable time frame
- the effects of the products of degradation have been considered.

Where MNA is proposed as part of an overall remedial strategy for ongoing management of groundwater contamination, the site auditor must assess whether or not the appropriateness of using MNA has been comprehensively examined by the proponent in the remedial action plan and whether the proponent's conclusions are appropriate.

A proposal for MNA at a site must demonstrate an understanding of the particular attenuation processes relevant to the contaminants of concern under the conditions at the site. MNA proposals must be supported by sufficient and appropriate field data and an ongoing monitoring program.

The auditor's role is to critically review the evidence presented by the MNA proposal and assess whether it is adequate to demonstrate

that natural attenuation is occurring, that remedial goals are capable of being met in an adequate time frame, and that the proposed monitoring program is suitable.

4.4 Evaluating land-use suitability

4.4.1 Decision-making process

In assessing the suitability of a site for an existing or proposed land use in an urban context, site auditors must follow the decision-making process for assessing urban redevelopment sites, as presented in Appendix I.

Where more than one land use is proposed for the site to which the audit relates (for example, commercial land use at the base of a building and residential upstairs), an auditor's assessment of the suitability of the site must be related to the more sensitive of the proposed land uses (see Appendix II).

4.4.2 Assessing land-use suitability where groundwater contamination is present

Where groundwater contamination is present, an auditor must discuss its impact on the suitability of the site for a proposed use in the site audit report. This applies equally to contamination originating from the site and contamination sourced off-site.

Where groundwater contamination under a site poses an unacceptable risk to users of the site for a proposed use, an auditor must indicate in the site audit statement that the site is unsuitable for that use.

Where groundwater contamination is present under a site but does not or is unlikely to make the site unsuitable for use because it does not pose an unacceptable risk to users of the site, an auditor may issue a site audit statement certifying that the land is suitable for a specific use despite the contamination, provided:

- the auditor has advised the person who commissioned the site audit in writing that groundwater contamination is present
- a copy of the advice to the person who commissioned the audit is appended to the site audit report and is also noted or summarised in the site audit statement
- the auditor has discussed with DEC whether any remediation may be required to address potential risks to off-site receptors and, if so, what regulatory mechanism may be required for this further work.

The auditor should explain that if future remediation is required this could interfere with activities on the site while remediation is carried out. The auditor should take reasonable steps to draw attention to any duty to report contamination under the CLM Act (see Section 4.2.5).

Impacts on buildings and structures

Where a site auditor considers that building structures on the site may be affected by the presence of contaminants in groundwater, they should recommend in the site audit report that specialist advice on possible impacts on structures is obtained.

REFERENCES

ANZECC 1994, *National Protocol Approval Licensing of Commercial-scale Facilities for the Treatment/Disposal of Schedule X Wastes*, Australian and New Zealand Environment and Conservation Council, Canberra

ANZECC 1996a, *Hexachlorobenzene Waste Management Plan*, Australian and New Zealand Environment and Conservation Council, Canberra

ANZECC 1996b, *Polychlorinated Biphenyls Waste Management Plan*, Australian and New Zealand Environment and Conservation Council, Canberra

ANZECC 1999, *Organochlorine Pesticides Waste Management Plan*, Australian and New Zealand Environment and Conservation Council, Canberra

ANZECC & ARMCANZ 2000, *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*, Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand, Canberra

ANZECC & NHMRC 1992, *Australian and New Zealand Guidelines for the Assessment and Management of Contaminated Sites*, Australian and New Zealand Environment and Conservation Council and National Health and Medical Research Council, Canberra

DUAP 1998, *State Environmental Planning Policy No. 55: Remediation of Land*, Department of Urban Affairs and Planning, Sydney

DUAP & EPA 1998, *Managing Land Contamination: Planning Guidelines*, Department of Urban Affairs and Planning and NSW Environment Protection Authority, Sydney

EPA 1994, *Guidelines for Assessing Service Station Sites*, NSW Environment Protection Authority, Sydney

EPA 1995a, *Guidelines for the Vertical Mixing of Soil on Broad-acre Agricultural Land*, NSW Environment Protection Authority, Sydney

EPA 1995b, *Sampling Design Guidelines*, NSW Environment Protection Authority, Sydney

EPA 1997, *Guidelines for Consultants Reporting on Contaminated Sites*, NSW Environment Protection Authority, Sydney

EPA 1999, *Environmental Guidelines: Assessment, Classification and Management of Liquid and Non-liquid Wastes*, NSW Environment Protection Authority, Sydney

Imray, P. & Langley, A. 2001, *Health-based Soil Investigation Levels*, enHealth Council, Soil Series No. 1, 3rd edition, Canberra

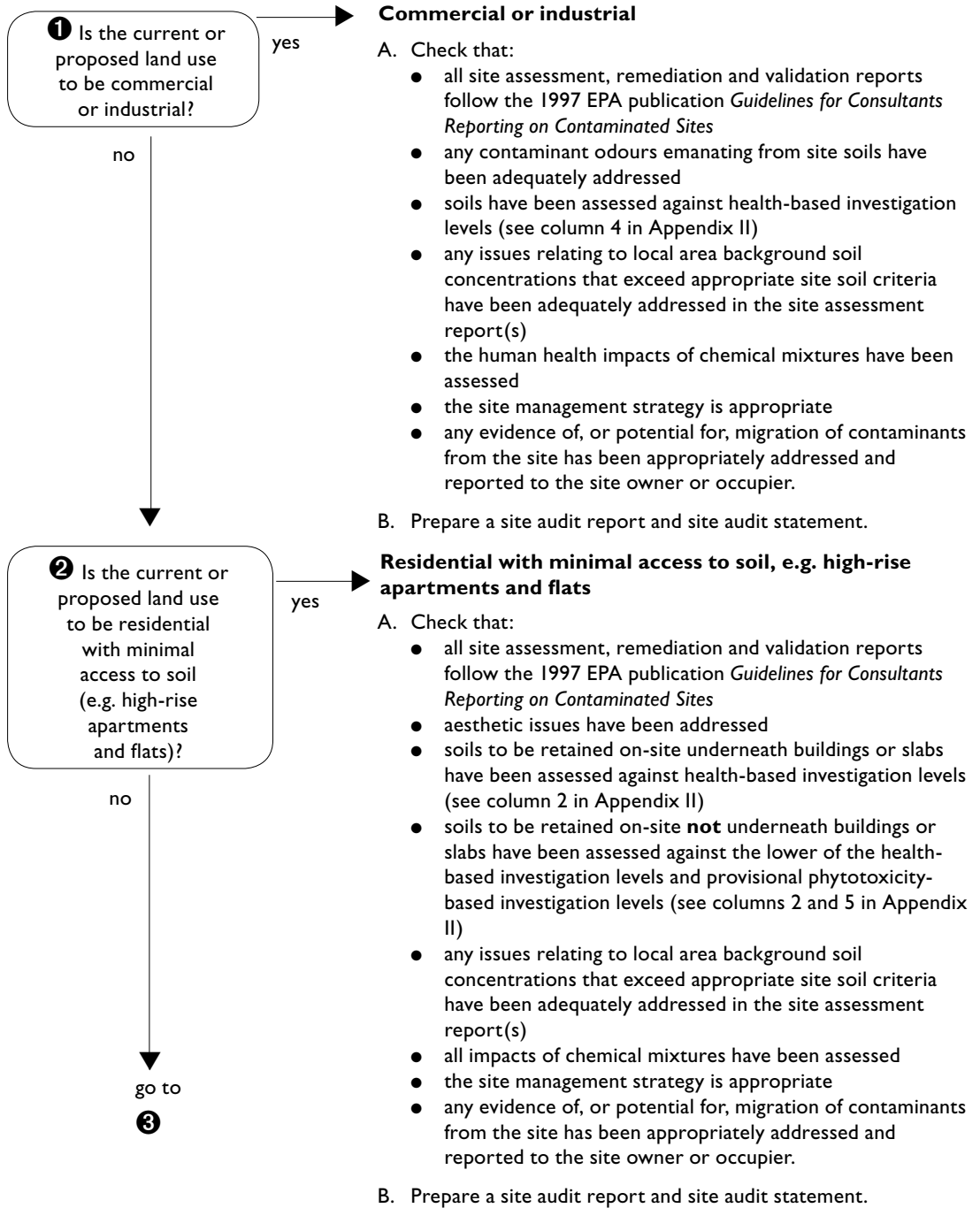
NEPC 1999, *National Environment Protection (Assessment of Site Contamination) Measure 1999*, National Environment Protection Council, Canberra

NHMRC & NRMCC 2004, *Guidelines for Drinking Water Quality in Australia*, National Health and Medical Research Council and Natural Resource Management Ministerial Council, Canberra

Taylor, R. & Langley, A. 2001, *Exposure Scenarios and Exposure Settings*, enHealth Council, Soil Series No. 2, 3rd edition, Canberra

APPENDIX I: Decision-making process for assessing urban redevelopment sites

Note: Where SILs are not available, or assessment against them is inconclusive for the site, and either an abridged or detailed human health site-specific risk assessment has been undertaken, check that all the requirements of the checklist in Appendix VII are satisfied.



③ Is the current or proposed land use to be residential with gardens and accessible soil (home produce contributing less than 10% fruit and vegetable intake; no poultry), including children's day-care centres, preschools or primary schools, or town houses or villas;
OR parks, recreational open space or playing fields, including secondary schools?

yes →

Residential with gardens and accessible soil (home produce contributing less than 10% fruit and vegetable intake; no poultry), including children's day-care centres, preschools or primary schools, or town houses or villas, OR Parks, recreational open space or playing fields, including secondary schools?

A. Check that:

- all site assessment, remediation and validation reports follow the 1997 EPA publication *Guidelines for Consultants Reporting on Contaminated Sites*
- aesthetic issues have been addressed
- soils have been assessed against the lower of the appropriate health-based investigation levels and provisional phytotoxicity-based investigation levels (see columns 1, 3 and 5 in Appendix II)
- any issues relating to local area background soil concentrations that exceed appropriate site soil criteria have been adequately addressed in the site assessment report(s)
- all impacts of chemical mixtures have been assessed
- the site management strategy is appropriate
- any evidence of, or potential for, migration of contaminants from the site has been appropriately addressed and reported to the site owner or occupier.

B. Prepare a site audit report and site audit statement.

no ↓

④ The current or proposed land use is residential with substantial vegetable garden and/or poultry, OR a more sensitive land use.

→

Residential with substantial vegetable garden and/or poultry, OR a more sensitive land use.

A. Check that:

- all site assessment, remediation and validation reports follow the 1997 EPA publication *Guidelines for Consultants Reporting on Contaminated Sites*
- aesthetic issues have been addressed
- the consultant has undertaken a detailed site-specific human health risk assessment that satisfies all the requirements of the checklist in Appendix VII, and includes a scientifically justified analysis of food-chain exposures
- the site has been assessed against the provisional phytotoxicity-based investigation levels (see column 5 in Appendix II)
- any issues relating to local area background soil concentrations that exceed the site soil criteria have been adequately addressed in the site assessment report(s)
- all impacts of chemical mixtures have been assessed
- the site management strategy is appropriate
- any evidence of, or potential for, migration of contaminants from the site has been appropriately addressed and reported to the site owner or occupier.

B. Prepare a site audit report and site audit statement.

APPENDIX II

Soil investigation levels for urban development sites in NSW

Substance	Health-based investigation levels ¹ (mg/kg)				Provisional phytotoxicity-based investigation levels ² (mg/kg)
	Residential with gardens and accessible soil (home-grown produce contributing < 10% fruit and vegetable intake; no poultry), including children's day-care centres, preschools, primary schools, townhouses, villas (NEHF A) ³	Residential with minimal access to soil including high-rise apartments and flats (NEHF D)	Parks, recreational open space, playing fields including secondary schools (NEHF E)	Commercial or industrial (NEHF F)	
	Column 1	Column 2	Column 3	Column 4	Column 5
Metals and metaloids					
Arsenic (total)	100	400	200	500	20
Beryllium	20	80	40	100	–
Cadmium	20	80	40	100	3
Chromium (III) ⁴	12%	48%	24%	60%	400
Chromium (VI)	100	400	200	500	1
Cobalt	100	400	200	500	–
Copper	1,000	4,000	2,000	5,000	100
Lead	300	1,200	600	1,500	600
Manganese	1,500	6,000	3,000	7,500	500
Methyl mercury	10	40	20	50	–
Mercury (inorganic)	15	60	30	75	1 ⁵
Nickel	600	2,400	600	3,000	60
Zinc	7,000	28,000	14,000	35,000	200
Organics					
Aldrin + dieldrin	10	40	20	50	–
Chlordane	50	200	100	250	–
DDT + DDD + DDE	200	800	400	1,000	–
Heptachlor	10	40	20	50	–
PAHs (total)	20	80	40	100	–
Benzo(a)pyrene	1	4	2	5	–
Phenol ⁶	8,500	34,000	17,000	42,500	–
PCBs (total)	10	40	20	50	–
Petroleum hydrocarbon components⁷					
> C16–C35 (aromatics)	90	360	180	450	–
> C16–C35	5,600	22,400	11,200	28,000	–
> C35 (aliphatics)	56,000	224,000	112,000	280,000	–
Other					
Boron	3,000	12,000	6,000	15,000	– ⁸
Cyanides (complex)	500	2,000	1,000	2,500	–
Cyanides (free)	250	1,000	500	1,250	–

- 1 The limitations of health-based soil investigation levels are discussed in Schedule B(1) Guidelines on the Investigation Levels for Soil and Groundwater and Schedule B(7a) Guidelines on Health-based Investigation Levels, *National Environment Protection (Assessment of Site Contamination) Measure 1999* (NEPC 1999)
- 2 The provisional phytotoxicity-based investigation levels proposed in this document are single number criteria. Their use has significant limitations because phytotoxicity depends on soil and species parameters in ways that are not fully understood. They are intended for use as a screening guide and may be assumed to apply to sandy loam soils or soils of a closely similar texture for pH 6–8.
- 3 National Environmental Health Forum (NEHF) is now known as enHealth.
- 4 Soil discolouration may occur at these concentrations.
- 5 Total mercury
- 6 Odours may occur at these concentrations.
- 7 The carbon number is an 'equivalent carbon number' based on a method that standardises according to boiling point. It is a method used by some analytical laboratories to report carbon numbers for chemicals evaluated on a boiling point GC column.
- 8 Boron is phytotoxic at low concentrations. A provisional phytotoxicity-based investigation level is not yet available.

Notes:

This table is adapted from Table 5-A in Schedule B(1): Guidelines on Investigation Levels for Soil and Groundwater to the *National Environment Protection (Assessment of Site Contamination) Measure 1999* (NEPC 1999).

Soil investigation levels (SILs) may not be appropriate for the protection of ground water and surface water. They also do not apply to land being, or proposed to be, used for agricultural purposes. (Consult NSW Agriculture and NSW Health for the appropriate criteria for agricultural land.)

SILs do not take into account all environmental concerns (for example, the potential effects on wildlife). Where relevant, these would require further consideration.

Impacts of contaminants on building structures should also be considered.

For assessment of hydrocarbon contamination for residential land use, refer to the *Guidelines for Assessing Service Station Sites* (EPA 1994).

APPENDIX III

Recognition of applicants under other schemes under the Mutual Recognition (New South Wales) Act 1992

Mutual recognition provisions and process

Part 3 of the Schedule to the *Mutual Recognition (New South Wales) Act 1992* applies the principle of mutual recognition to occupations. It deals with the ability of a person who is registered in connection with an occupation in one Australian State to carry on an equivalent occupation in another State.⁶ Registration includes accreditation.

The mutual recognition principle is that, subject to the provisions of Part 3 of the Mutual Recognition Act, if an individual is registered for an occupation in the first State, after notifying the local registration authority for the equivalent occupation in the second State, they are entitled:

- to be registered for the equivalent occupation in the second State
- pending their registration, to carry on the equivalent occupation in the second State.

Auditors registered/accredited in another State who wish to be accredited in NSW under the mutual recognition principle must lodge a written notice with DEC. The notice must:

- state that they are registered for the occupation in another State and specify that State
- state the occupation for which they are seeking accreditation and that they are seeking it in accordance with the mutual recognition principle
- specify all the States in which they have substantive accreditation for the equivalent occupation
- state that they are not the subject of disciplinary proceedings in any State (including any preliminary investigations or action that might lead to disciplinary proceedings) in relation to that occupation
- state that their accreditation in any State is not cancelled or currently suspended as a result of disciplinary action
- state that they are not otherwise prohibited from carrying on any such occupation in any State, and are not subject to any special

⁶ All references to a 'State' should also be read as including the Australian Capital Territory and the Northern Territory.

conditions in carrying on that occupation, as a result of criminal, civil or disciplinary proceedings in any State

- specify any special conditions to which they are subject in carrying on any such occupation in any State
- give consent to the making of inquiries of, and the exchange of information with, the authorities of any State regarding their activities in the relevant occupation or occupations or otherwise regarding matters relevant to the notice.

The notice must be accompanied by a document that is either the original or a copy of the instrument evidencing the existing registration in the other State (or if there is no such instrument, by sufficient information to identify them and their registration).

The notice must certify that the accompanying document evidencing the person's existing registration is the original or a complete and accurate copy of the original. The statements and other information in the notice must be verified by a statutory declaration.

DEC may permit the notice to be amended after it is lodged.

DEC must either grant, postpone or refuse to grant accreditation within one month of the notice being lodged with it. When granted, accreditation takes effect from the date of the lodgement.

If DEC fails to grant, postpone or refuse accreditation within one month, the person concerned is entitled to accreditation immediately at the end of that period, and no objection may be taken to the notice on any of the grounds on which accreditation may be refused or postponed, except where fraud is involved.

Prior to being accredited, applicants must pay the appropriate accreditation fee.

Once accredited in NSW, an auditor's entitlement to accreditation continues, whether or not their accreditation continues in the other State. However, if accreditation in one State is cancelled or suspended or is subject to a condition on disciplinary grounds, or as a result of or in anticipation of criminal, civil or disciplinary proceedings, then accreditation in the other State is affected in the same way. The authority in the other State can choose to reinstate the auditor or waive the conditions.

DEC may impose conditions on accreditation, but may not impose conditions that are more onerous than would be imposed in similar circumstances (having regard to relevant qualifications and experience) if the accreditation were granted under the *Contaminated Land Management Act 1997* instead of Part 3 of the Mutual

Recognition Act. This is subject to the proviso that DEC may attach the conditions that apply to the accreditation in the other State or that are necessary to achieve equivalence of occupations.

Once an individual is registered in NSW through mutual recognition, continuance of registration is subject to the laws of NSW.

Postponement of accreditation

DEC may postpone the granting of accreditation if:

- any of the statements or information in the notice as required under the Mutual Recognition Act is materially false or misleading, or
- any document or information that must accompany the notice has not been provided or is materially false or misleading, or
- an auditor's circumstances have materially changed since the date of the notice or the date on which they lodged the notice, or
- DEC decides that the occupation in which they are seeking accreditation is not an equivalent occupation.

If DEC postpones the granting of accreditation, it may subsequently either grant accreditation or refuse to grant it, provided that the postponement is for not longer than six months. At the end of this period, unless registration has been refused, auditors are entitled to be accredited immediately.

Refusal of accreditation

DEC may refuse accreditation if:

- any of the statements or information given in the notice is materially false or misleading, or
- any document or information that must accompany the notice has not been provided or is materially false or misleading, or
- DEC decides that the occupation in which accreditation is being sought is not an equivalent occupation, and equivalence cannot be achieved by imposing conditions.

If DEC refuses accreditation on the last ground above, that decision takes effect at the end of a specified period (not less than two weeks) after an auditor is notified of the decision, unless in the meantime the decision is revoked or they make an application for review of decision under the provisions of the Mutual Recognition Act. If they apply for review, the review body (the Administrative Appeals Tribunal) can make whatever orders it considers appropriate.

Deemed accreditation

The mutual recognition principle includes provision that once a person seeking accreditation as a site auditor in NSW under the Mutual Recognition Act has notified DEC in accordance with the requirements of the Act, that person is entitled to carry on that occupation pending notice of DEC's decision. This is called 'deemed accreditation'. Note, however, that deemed accreditation in one State cannot itself provide the basis for accreditation or registration in another State.

If an auditor has deemed accreditation in NSW, that deemed accreditation ceases if:

- they are granted substantive accreditation in NSW, or
- DEC refuses to grant substantive accreditation (subject to determination of any application for review of that decision), or
- they cease to be registered in every other State on the basis of which the notice seeking accreditation in NSW has been lodged, or
- they request cancellation.

Deemed accreditation is not affected if DEC decides to postpone the grant of substantive accreditation.

If an auditor has deemed accreditation in NSW, they may carry on the activities of a site auditor, but only:

- within the limits of their registration/accreditation in another State, and subject to any conditions that apply to it in that State (unless DEC in NSW has waived those conditions)
- within the limits conferred by the deemed accreditation in NSW and subject to any conditions that DEC imposes on that deemed accreditation.

Note that, so far as deemed accreditation in NSW is concerned, DEC has the power to waive any conditions that apply to a registration/accreditation in another State.

However, DEC may impose conditions on deemed accreditation in NSW, provided those conditions are not more onerous than those that would be imposed in similar circumstances (having regard to relevant qualifications and experience) if the accreditation were effected under the *Contaminated Land Management Act 1997*. This is subject to the proviso that DEC may attach conditions that apply to the accreditation in another State or that are necessary to achieve equivalence of occupations.

Note also that DEC imposes the following conditions on deemed accreditation in NSW:

- the site auditor must comply with insurance requirements specified by DEC, which are designed to protect the public, clients, customers or others
- the site auditor is subject to any disciplinary provisions and arrangements that apply to accredited site auditors
- the site auditor complies with all laws of NSW that apply to accredited site auditors.

APPENDIX IV

Data quality objectives: Outline of the DQO process

The Data Quality Objectives (DQOs) process is used to define the type, quantity and quality of data needed to support decisions relating to the environmental condition of a site. It provides a systematic approach for defining the criteria that a data collection design should satisfy, including when, where and how to collect samples or measurements; determination of tolerable decision error rates; and the number of samples or measurements that should be collected.

DQOs must be adopted for all assessment and remediation programs. Site auditors must check that the consultant has properly addressed and adopted DQOs for the investigation or validation program and that the consultant's report includes the following:

- a statement of pre-determined DQOs for field and laboratory procedures, including quantitative DQOs
- a plan to achieve pre-determined DQOs
- procedures to be undertaken if the data does not meet the expected DQOs.

The US Environmental Protection Agency (USEPA) describes the DQO process as a seven-step iterative planning approach used to prepare plans for environmental data collection and is summarised below.

For more details about DQOs and the DQO process, refer to the USEPA 2000 documents *Guidance for the Data Quality Objective Process* and *Data Quality Objectives Process for Hazardous Waste Site Investigations*.

Timing

The timing for the various stages of the project must be clearly understood by all parties prior to commencing any work on the project.

The DQO process must be commenced before any investigative work begins on the project.

Step 1: State the problem

Purpose

Summarise the contamination problem that will require new environmental data, and identify the resources available to resolve the problem; develop a conceptual site model

Matters considered in this step

- The objective (purpose) of the proposed investigation (the ability to meet objectives may be limited by constraints such as time, resources, money, climatic conditions, access restrictions)
- A problem statement: a brief summary of the contamination issue(s) at the site that are to be addressed in the project
- The reason the project is being undertaken
- Identify the project team and technical support experts, such as field manager, field personnel, toxicologists, risk assessors, statisticians, etc.
- Other matters such as the budget and community concern issues which may also be factors in designing and carrying out the environmental assessment
- Identification of the regulatory authority(ies) and the local government area

Expected outputs

- A concise description of the problem
- A list of the planning team members and identification of decision-maker
- A summary of available resources and relevant deadlines for the study
- A conceptual model of the site based on available information prior to the commencement of the site investigation covering:
 - previous investigations
 - historical uses of the site
 - geology, hydrogeology
 - present and past use(s) of adjacent sites
 - chemicals of concern
 - potential contaminant migration pathways both to and from the site (waterways, drains, service conduits)
 - areas of environmental concern (drawings showing chemical storage, use, disposal)
 - media in which chemicals of concern may be present and through which they may migrate (habitat(s) of contamination, lateral, depth extent, temporal, climatic variability)

- potential exposure pathways to human and/or environmental receptors
- clean-up concerns
- future land uses.

The conceptual model of contamination on each segment of the site is proposed as early as possible and progressively refined through all stages of the investigation.

Step 2: Identify the decisions

Purpose

Identify the decisions that need to be made on the contamination problem and the new environmental data required to make them

This step identifies the objective(s) of the data collection part of the investigation by:

- referring to the history of use of the site, chemicals of concern and likely concentration ranges, media that may be impacted and likely migration routes, such as groundwater, surface water flow, wind, service trenches
- considering relevant site criteria for each medium (fill, soil, sediment, groundwater, surface water, air)
- making a series of decision statements that need to be addressed (for example a decision statement could consider whether parts of the site would be suitable for a proposed use if the 95% UCL on the mean concentrations for all chemicals of potential concern were less than the site criteria)

Expected outputs

A decision statement that links the principal study question to possible actions that will solve the problem

Refining the model

Review the existing conceptual model to determine whether existing data is satisfactory for the investigation or whether data gaps or uncertainty exist

Step 3: Identify inputs to decision

Purpose

Identify the information needed to support any decision and specify which inputs require new environmental measurements

Decisions made during this step are of a 'draft' or preliminary nature and are reviewed in Step 7 to derive the optimal design for the Sampling Analytical and Quality Plan.

Expected outputs

- A list of informational inputs needed to resolve the decision statement
- A list of environmental variables or characteristics that will be measured
- The information required to allow informed, defensible decisions to be made and decisions that need to be made to resolve decision statements
- Identification of the media, such as fill, soil, groundwater, sediments, surface water and air, that need to be collected
- Identification of the site criteria for each medium of concern
- Identification of the analytical methods that are required for chemicals of potential concern so that assessment can be made relative to the site criteria
- Defining the basis for any decisions that are to be made from field screening, such as from PID data, what action to be taken if a defined concentration is attained
- A list of additional information required to make decisions

Step 4: Define the study boundaries

Purpose

Specify the spatial and temporal aspects of the environmental media that the data must represent to support decision

Matters considered in this step

- The geographical extent of the proposed investigation, time and budget constraints
- The boundaries may be both spatial (property boundaries, accessibility to parts of the site, potential exposure areas) or temporal (the time frame of the investigation taking into account seasonal conditions, presence of near-surface groundwater or surface water and discharges, access restrictions, availability of key personnel)
- Definitions of the segments of the site that are required to be investigated (consider the use proposed for the site which will influence required sample density, NSW DEC guidelines, etc.)

- Divide the site into strata in which contamination distribution is believed to be uniformly distributed
- Consider the scale of required decisions: site-wide, each residential lot, etc.
- Consider the presence of heterogeneous materials that require special sampling methods
- Identify potential constraints to carrying out the investigation, such as access, health and safety issues

Expected outputs

- A detailed description of the spatial and temporal boundaries of the problem
- Any practical constraints that may interfere with the study

Step 5: Develop a decision rule

Purpose

To define the parameter of interest, specify the action level, and integrate previous DQO outputs into a single statement that describes a logical basis for choosing from alternative actions

Matters considered in this step

Defining acceptable limits for:

- Chemicals of concern detected in field blanks, rinsate blanks, volatile-spiked trip samples, laboratory method blanks
- Recovery of matrix spike additions, surrogate spike additions, laboratory control samples
- RPDs of matrix spike and matrix spike duplicates.

Expected outputs

- The statistical parameter (the parameter of interest) that characterises the population
- Confirmation that the action level exceeds measurement detection limits
- An ‘if . . . , then . . . ’ statement that defines the conditions that would cause a decision-maker to choose from alternative actions

Step 6: Specify limits on decision errors

Purpose

Specify the decision-maker's acceptable limits on decision errors, which are used to establish performance goals for limiting uncertainties in the data (for more on decision errors, see note below)

Matters considered in this step

- Determine the possible range of the parameter of interest
- Identify the decision errors and choose the null hypothesis
- Specify a range of possible parameter values where the consequences of decision errors are relatively minor
- Assign probability values to points above and below the action level that reflect the tolerable probability for the occurrence of decision errors.

Expected outputs

Decision-maker's tolerable decision error rates based on a consideration of the consequences of making an incorrect decision

Step 7: Optimise the design for obtaining data

Purpose

Identify the most resource-effective sampling and analysis design for general data that are expected to satisfy the DQOs

Expected outputs

- The most resource-effective design for the study that is expected to achieve the DQOs
- The optimum manner in which to collect the data required to meet the objectives for the assessment and which will meet the project DQOs
- Development of the sampling analytical and quality plan (SAQP) (see Appendix V).

Note on decision errors

These are incorrect decisions caused by using data that is not representative of site conditions because of sampling or analytical error, that is used to decide that site clean-up is not needed when it really is, or *vice versa*.

Decision errors are of two types:

- **Sampling errors** which occur when the sampling program does not adequately detect the variability of a contaminant from point to point across the site, that is the samples collected are not representative of the site conditions (for example, an appropriate number of representative samples must be collected from each stratum to account for estimated variability).
- **Measurement errors** which occur during sample collection, handling, preparation, analysis and data reduction.

The combination of the above errors is referred to as 'total study error'. This directly affects the probability of making decision errors. Study error is managed through the correct choice of sample design and measurement systems.

Attainment of a nominated probability generally requires use of a statistically based sampling plan.

Decision-making

The possibility of making a decision error, although small, is undesirable because of the adverse consequences arising from that incorrect decision. It can be controlled through the use of hypothesis testing. This test can be used to show either that the baseline condition is false (and therefore the alternative condition is true) or that there is insufficient evidence to indicate that the baseline condition is false (and therefore the site manager decides by default that the baseline condition is true). The burden of proof is placed on rejecting the baseline condition, because the test hypothesis structure maintains the baseline condition as being true until overwhelming evidence is presented to indicate that the baseline condition is not true.

Null hypothesis

This is an assumption assumed to be true in the absence of contrary evidence, for example the site is dirty unless proved to be clean.

If we reject a hypothesis when it should be accepted, we say that a **type I error** has been made. If, on the other hand, we accept a hypothesis when it should be rejected, we say that a **type II error** has been made. In either case, a wrong decision or error in judgment has occurred.

- **Type I error (false positive decision error)** – Rejecting the hypothesis as false when it is really true
- **Type II error (false negative decision error)** – Accepting the hypothesis as true when it is really false

In order for decision rules (or tests of hypotheses) to be sound, they must be designed to minimise errors of decision. This is not always simple, as for any given sample size, an attempt to decrease one type of error is generally accompanied by an increase in the other type of error. The only way to reduce both types of error is to increase the sample size, which may or may not be always possible.

Level of significance

In testing a given hypothesis, the maximum probability with which we would be willing to risk a Type I error is referred to as the 'level of significance' or significance level of test. A significance level of 0.05 or 0.01 is customary, although other values are used. If for example the 0.05 (or 5%) significance level is chosen in designating a decision rule, there are about 5 chances in 100 that we would reject the hypothesis when it should be accepted; that is we are about 95% confident that we have made the right decision. In such cases we say that the hypothesis has been rejected at the 0.05 significance level, which means that the hypothesis has a 0.05 probability of being wrong.

As a general rule, 95% confidence is used for sensitive land use, but 90% may be acceptable for non-sensitive land uses.

APPENDIX V

Quality assurance and quality control

Assessment of reliability of field procedures and laboratory results

Site auditors must ensure that an assessment of the reliability of field procedures and analytical results has been undertaken by the consultant by using the Data Quality Indicators (DQI) (precision, accuracy, representativeness, completeness and comparability).

DQI are used to document and quantify compliance, or otherwise, with the requirements of the project Sampling, Analytical and Quality Plan (SAQP).

QA/QC analytical methods

The DQI for chemical data will differ depending on which analytical methods have been used in a site assessment. These fall into three main categories:

- field methods
- laboratory screening methods
- methods specific for contaminants that are known or expected to be present at a site.

Field methods

Site auditors must check that:

- the applicability and limitations of field methodology are discussed appropriately in contaminated site consultants' reports
- the consultant has ensured adequate calibration of instruments and validation of field measurements, including comparison with laboratory results
- the consultant's report has adequately assessed the significance of the results of field screening methods compared with the results of laboratory analyses, for example that the results reported for field screening using a photo-ionisation detector are compatible with the results reported by the laboratory for volatile organic compounds and where not compatible, auditors must check that the consultant's report has adequately explained this.

Laboratory screening methods

Laboratory screening methods are used to determine the type of contamination present and the constituents of a sample that might cause interferences in specific methods.

Site auditors must check that the applicability and limitations of screening methodology used by the laboratory are appropriately discussed in the consultant's report.

DQI for screening methods might be less rigorous than for specific analytical methods. Nevertheless, screening method performance must be known and should be expressed as a multiple of specific analytical method performance.

Methods specific for contaminants

Site auditors must check that:

- the analytical methods used for site validation are of appropriate precision and accuracy, and that the sensitivity and selectivity of the analytical methods are appropriate for the assessment of the risk
- the precision and accuracy criteria set out in the consultant's QA/QC plan, for a given method and matrix, meet the performance expected of the reference method
- consultants include in their reports written documentation on quality of data supplied by the analytical laboratory which meets the objectives of the testing laboratory's quality plan for at least 95% of test results. (Note these DQOs do not refer to field duplicate reproducibility or other measures of sampling variance. Sampling variance should be addressed in the choice of sampling method.)

Data Quality Indicators (DQIs)

The DQIs, as indicated on the next two pages, relate to both field and laboratory procedures, which site auditors must check have been appropriately assessed by the consultants in their reports.

Completeness

A measure of the amount of useable data (expressed as %) from a data collection activity

Field considerations	Laboratory considerations	Comments
All critical locations sampled All samples collected (from grid and at depth) SOPs appropriate and complied with Experienced sampler Documentation correct	All critical samples analysed according to SAQP All analytes analysed according to SAQP Appropriate methods and PQLs Sample documentation complete Sample holding times complied with	The required percentage completeness should be specified in the SAQP. All required data must be obtained for critical samples and chemicals of concern. Incompleteness is influenced by: <ul style="list-style-type: none"> • field performance problems (access problems, difficulties on site, damage, ...) • laboratory performance problems (matrix interference, invalid holding times, ...) • matrix problems

Comparability

The confidence (expressed qualitatively) that data may be considered to be equivalent for each sampling and analytical event

Field considerations	Laboratory considerations	Comments
Same SOPs used on each occasion Experienced sampler Climatic conditions (temperature, rainfall, wind, ...) Same types of samples collected (filtered, size fractions, ...)	Sample analytical methods used (including clean-up) Sample PQLs (justify/quantify if different) Same laboratories (justify/quantify if different) Same units (justify/quantify if different)	Same approach to sampling (SOPs, holding times...) Quantify influence from climatic or physical conditions Samples collected, preserved, handled in same manner (filtered, same containers)

Representativeness
 The confidence (expressed qualitatively) that data are representative of each media present on the site

Field considerations	Laboratory considerations	Comments
Appropriate media sampled according to SAQP All media identified in SAQP sampled	All samples analysed according to SAQP	Samples must be collected to reflect the characteristics of each media Sample analyses must reflect properties of field samples Homogeneity of the samples Appropriate collection, handling, storage and preservation Detection of laboratory artefacts, e.g. contamination blanks

Precision
 A quantitative measure of the variability (or reproducibility) of data

Field considerations	Laboratory considerations	Comments
SOPs appropriate and complied with	Analysis of: <ul style="list-style-type: none"> • laboratory and interlaboratory duplicates • field duplicates • laboratory-prepared volatile trip spikes 	Measured by the coefficient of variance or standard deviation of the mean or by RPDs Field duplicates measure field and laboratory precision Laboratory duplicates measure analytical precision

Accuracy (bias)
 A quantitative measure of the closeness of reported data to the true value

Field considerations	Laboratory considerations	Comments
SOPs appropriate and complied with	Analysis of: <ul style="list-style-type: none"> • field blanks • rinsate blanks • reagent blanks • method blanks • matrix spikes • matrix spike duplicates • surrogate spikes • reference materials • laboratory control samples • laboratory-prepared spikes 	Bias introduced: <ul style="list-style-type: none"> • by chemicals during handling or transport • from contaminated equipment • from contaminated reagents • during laboratory analysis • during laboratory preparation and analysis (may be high or low) • precision of preparation and analytical method

Field QA/QC

The site auditor must check the following in reviewing the consultant's report:

- the consultant's field QA/QC program includes replicate samples split in the field and submitted to two separate laboratories in accordance with the requirements of the *National Environment Protection (Assessment of Site Contamination) Measure 1999*
- the consultant's sampling program includes assessment of all relevant environmental media, including soil, dust, surface water, groundwater, air, sediments and biota
- the sampling strategy is appropriate for the conditions at the site and the nature of the contamination with the rationale for the strategy described in the consultant's report and the sampling locations shown on a scaled site sampling plan
- sample collection, handling and transportation procedures are documented and appropriate to meet the project DQOs
- sampling is representative of site conditions, based on the selection of appropriate number of sampling points and of samples from each relevant strata and material types stated in a site sampling plan to meet the project DQOs
- a field QA/QC plan has been included in the consultant's report, which includes details of:
 - the sampling team
 - sampling method(s), including the actual methods employed for obtaining samples, type(s) of sample containers, order and degree of filling, preservation, labelling, logging, custody
 - evidence of appropriate decontamination procedures carried out between sampling events
 - logs for each sample collected showing time, location, initials of sampler, duplicate locations, duplicate type, chemical analyses to be performed, site observations and weather conditions
 - chain of custody documentation fully identifying for each sample the name of the sampler, the nature of the sample, collection date, analyses to be performed, sample preservation method, departure time from the site and dispatch courier(s) and condition of samples at dispatch
 - sample splitting techniques
 - a statement of duplicate frequency for intra-laboratory and inter-laboratory duplicate samples and duplicate sample results
 - field blank results

- background sample results
- rinsate sample results
- laboratory-prepared trip spike results for volatile analytes
- trip blank results
- field instrument calibrations on-site (when used).

Laboratory QA/QC

The site auditor must check that the consultant's report(s) includes the following in its review of the laboratory data:

- sample analyses use appropriate methodologies for each potential contaminant in the matrix in laboratories accredited for those analyses by the National Association of Testing Authorities (NATA) or an equivalent (government-endorsed provider of accreditation for laboratories)
- appropriate Practical Quantitation Limits for the chemicals of concern for use in the assessment of risk
- a laboratory QA/QC plan with the following information:
 - a copy of signed chain-of-custody forms acknowledging receipt date and time, conditions of samples on receipt and identity of samples included in shipments
 - record of holding times and a comparison with method specifications
 - analytical methods used
 - laboratory accreditation for analytical methods used
 - laboratory performance in inter-laboratory trials for the analytical methods used, where available
 - the results for blind duplicate samples collected from the field.

QA/QC documentation

The site auditor must check that the consultant's site assessment, remediation, monitoring and validation reports includes a QA/QC narrative describing all information relevant to the site assessment and that the consultant's reports include:

- the QA/QC checklist items in the *Guidelines for Consultants Reporting on Contaminated Sites* (EPA 1997) related to field quality assurance and quality control, laboratory QA/QC and data evaluation QA/QC

- the names of the accredited laboratories used and relevant details of their accreditation for each analytical method
- the limits of reporting (ensuring that appropriate assessment can be made according to site criteria as stated in the DQOs for relevant media)
- the acceptance limit(s) for each QC test, such as duplicate relative percentage differences (RPDs) and recoveries for laboratory quality control analyses
- where used, the origin of certified reference material (CRM), its batch number and the concentrations of the chemicals of potential concern
- the QC results relevant to the sample analysis
- for each sample, the highest measurement result wherever replicate measurements are taken (or all measurement results for each sample)
- results for all data tabulated separately according to each type of soil, fill materials, groundwaters, surface waters and sediments, with appropriate statistical analysis according to the *National Environmental Protection (Assessment of Site Contamination) Measure 1999* requirements
- the laboratory specifying compliance with the requirements of the NEPM and equivalence with the reference method or non-standard methods.

APPENDIX VI

Examples of consent, licence, notification and other requirements

Regulatory consent, licences, notifications and other requirements may apply for some aspects of contaminated site investigation, remediation and validation work. These may include:

- a licence from the Department of Natural Resources (DNR) to establish a groundwater bore for any purpose
- DNR's approval, where necessary, for excavation, dredging or other works within the bed of a water body, or within 40 metres of the banks of any water body, or on a floodplain (approval may also be required for clearing of vegetation)
- approval from Sydney Water, or the relevant local water authority, for the discharge of contaminated water to sewer
- some classes of demolition work to be undertaken by contractors licensed by WorkCover NSW
- development consent or building approval for some classes of demolition work from the relevant planning authority
- notifications of WorkCover NSW when underground storage tanks licensed by it are being decommissioned
- notifications of the planning authority of, and in some cases seeking consent for, remediation activities in accordance with the requirements of *State Environmental Planning Policy No. 55: Remediation of Land* (DUAP 1998)
- remedial works that:
 - are classed as Category I works under SEPP 55 and require development consent
 - can constitute a 'designated development' under Schedule 3 of the Regulations to the *Environmental Planning and Assessment Act 1979* requiring development consent by the planning authority
 - are undertaken on a Major Project as defined under part 3A of the *Environmental Planning and Assessment Act 1979* and thus require approval from the Minister for Planning
 - must comply with the requirements of any relevant state environmental planning policies, regional environmental planning policies and local environmental plans
 - must comply with guidelines made or approved by DEC under the *Contaminated Land Management Act 1997* or any other legislation

- DEC and/or planning authority licences for the discharge of chemicals into the environment, such as the release of chemicals to air, or discharge of potentially contaminated waters to stormwater drains
- DEC licences for the transportation, treatment and disposal of wastes under the *Protection of the Environment Operations Act 1997*
- sites subject to DEC regulatory control, where written consent must be obtained before prescribed actions are commenced, such as notices issued under s.35 of the *Environmentally Hazardous Chemicals Act 1985* and s.28 of the *Contaminated Land Management Act 1997*.

APPENDIX VII

Human health risk assessment checklist

The following is a checklist that must be used by an auditor to review any human health risk assessments undertaken by a consultant. Where the auditor's check reveals that the consultant's risk assessment has omitted one or more of the points specified in the checklist, the auditor must document this in the site audit report and take this into account in reaching their site audit conclusions.

Hazard identification

- Have all appropriate sources of information regarding chemicals of potential concern been identified and appraised?
- Has justification been given for the selection of the chemicals of potential concern?
- Has justification been given for the omission of chemicals from the analysis?

Toxicological information

- Have all relevant toxicological facts been checked for accuracy and currency?
- Has the adequacy of the available toxicological database been commented on?
- Have the effects on each body system (for example renal, hepatic, cardiovascular and developmental) and the types of effects (for example genotoxic and carcinogenic) been summarised?
- Have all relevant allergic/idiosyncratic toxicological effects been noted?
- Have the critical toxic effects been identified?
- Has the experimental basis of the toxicological reference dose or potency factor, where applicable, been discussed and the uncertainties noted?
- Have the NHMRC (where applicable) or World Health Organisation (WHO) toxicological assessments been considered as the primary toxicological resource?
- Where relevant, have differences between, for example, WHO and US Environmental Protection Agency (USEPA) toxicological assessments been discussed?
- Has the dose-response relationship for chemicals of potential concern been discussed?

- Has the data been presented in a form amenable to efficient interpretation and review?

Exposure assessment

- Has the potentially exposed population been identified?
- Have potentially exposed, unusually susceptible sub-populations been identified?
- Have the estimates of chemical exposure for each exposure route and chemical of potential concern been quantified and tabulated?
- In cases of presumed insignificant risk, has the risk been demonstrated to be small?
- Has the relative significance of each exposure pathway, based on the risk analysis, been discussed?

Equations

- Have all equations used in the risk assessment been presented in the report?
- Are all equations consistent?
- Have all parameters in each equation been clearly defined?
- Have the correct units been allocated to each parameter?
- Are all equations dimensionally correct?
- Have all unit conversion factors, where applicable, been included in the equations?
- Has all pertinent information been provided to enable calculations to be checked through in a step-wise process?

Data evaluation

- What were the data collection objectives and are they consistent with the requirements of the risk assessment?
- Have the laboratories that did the chemical analyses been noted, and do they have NATA accreditation (or equivalent) to perform each particular chemical analysis?
- Has laboratory QA/QC been reported and analysed?
- Has field QA/QC been reported and analysed?
- Where appropriate, has the size of any 'hot spot' detected by the sampling pattern been stated?
- Have statements of the accuracy of the laboratory data for each contaminant been made?

Assessment and report presentation

- Have all tables and figures been referred to correctly in the text of the report?
- Has information from other sites been excluded from the report?
- Has information from previous reports on the site been appropriately selected and incorporated into this report?
- Have all assumptions and default data been identified and justified?
- Has the analysis been based on an up-to-date literature appraisal?
- Have all conclusions been justified?
- If toxicological data and the exposure scenario lead to the conclusion that a high concentration of contaminant is permissible, does the result violate ecological, aesthetic, land-use or physical principles?
- Has a risk management decision been made during the course of the risk assessment and, if so, how might that have influenced the calculation of risk?
- Has a detailed uncertainty discussion been included in the report?
- Has information been presented coherently and in an appropriate sequence to enable efficient appraisal of the report?

APPENDIX VIII

Declaration for an applicant to NSW Site Auditor Scheme

(Strike through the non-applicable response)

Have you ever been refused a licence, permit or authority under any environment protection or planning legislation or had any such licence, permit or authority revoked or withdrawn either in Australia or elsewhere? **Yes/No**

Has any company of which you are or were, at the relevant time, a director or officer been refused a licence, permit or authority under any environment protection or planning legislation or had any such licence, permit or authority revoked or withdrawn in Australia? **Yes/No**

Has any company of which you are or were, at the relevant time, a director or officer been refused a licence, permit or authority under any environment protection or planning legislation or had any such licence, permit or authority revoked or withdrawn in relation to overseas sites or projects for which you have been directly involved? **Yes/No**

Have you been convicted of or are you presently charged with committing an offence under any environment protection or planning legislation or other laws either in Australia or elsewhere? **Yes/No**

Has any company of which you are or were, at the relevant time, a director or officer been convicted of or been presently charged with committing an offence under any environment protection or planning legislation or other laws in Australia? **Yes/No**

Has any company of which you are or were, at the relevant time, a director or officer been convicted of or been presently charged with committing an offence under any environment protection or planning legislation in relation to overseas sites or projects for which you have been directly involved? **Yes/No**

Are you aware of any circumstances that may detrimentally affect your ability to fulfill the obligations of a site auditor accredited under the *Contaminated Land Management Act 1997*? **Yes/No**

If you have answered Yes to any of the above, please provide details (attach extra pages if there is insufficient space below).

(Signature)

(Date)

(Print name)

APPENDIX IX

NSW legislative instruments

Legislation

Available from the NSW Government Information Service, phone (02) 9743 7200 or the NSW Parliamentary Counsel's Office website at www.legislation.nsw.gov.au:

- *Contaminated Land Management Act 1997*
- Contaminated Land Management Regulation 1998
- *Environmentally Hazardous Chemicals Act 1985*
- *Environmental Planning and Assessment Act 1979*
- *Mutual Recognition (New South Wales) Act 1992*
- *Protection of the Environment Operations Act 1997*
- *Waste Avoidance and Resource Recovery Act 2001*

Chemical control orders

Available from the Department of Environment and Conservation NSW, phone 131 555 or (02) 9995 5000:

- Aluminium Smelter Wastes Containing Fluoride and/or Cyanide Chemical Control Order 1986
- Dioxin-Contaminated Wastes Chemical Control Order 1986
- Organotin Waste Materials Chemical Control Order 1989
- PCB Chemical Control Order 1997
- Scheduled Chemical Wastes Chemical Control Order 2004

APPENDIX X

Guidelines made or approved under the CLM Act

The *Contaminated Land Management Act 1997* (CLM Act) allows the EPA to make or approve guidelines for purposes connected with the objects of the Act. These guidelines must be taken into consideration by DEC, acting on behalf of the EPA, whenever they are relevant and by accredited site auditors when conducting a site audit. They are also used by contaminated land consultants in undertaking investigation, remediation, validation and reporting on contaminated sites.

A list of guidelines made or approved by the EPA under the CLM Act current at September 2005 appears below. To check the current list of approved documents visit www.environment.nsw.gov.au/clm/guidelines.htm which also provides links to most documents. To obtain hard copies of guidelines, contact Environment Line on 131 555.

Guidelines made by the EPA

Guidelines for Assessing Service Station Sites (December 1994)

Guidelines for the Vertical Mixing of Soil on Former Broad-acre Agricultural Land (January 1995)

Sampling Design Guidelines (September 1995)

Guidelines for Assessing Banana Plantation Sites (October 1997)

Guidelines for Consultants Reporting on Contaminated Sites (November 1997)

Guidelines on Significant Risk of Harm from Contaminated Land and the Duty to Report (April 1999)

Guidelines for Assessing Former Orchards and Market Gardens (June 2005)

Note: All references in the EPA's contaminated sites guidelines to the *Australian Water Quality Guidelines for Fresh and Marine Waters* (ANZECC, November 1992) are replaced as of 6 September 2001 by references to the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC & ARMCANZ, October 2000), subject to the same terms.

Guidelines approved by the EPA

ANZECC publications

ANZECC & ARMCANZ 2000, *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*, Australian and New Zealand

Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand, Paper No. 4, October 2000

ANZECC & NHMRC 1992, *Australian and New Zealand Guidelines for the Assessment and Management of Contaminated Sites*, published by Australian and New Zealand Environment and Conservation Council and the National Health and Medical Research Council, January 1992

enHealth publications

[formerly National Environmental Health Forum monographs]

Department of Health and Ageing and enHealth Council 2002, *Environmental Health Risk Assessment: Guidelines for assessing human health risks from environmental hazards*, Commonwealth of Australia, June 2002

Lock, W.H. 1996, *Composite Sampling*, National Environmental Health Forum Monographs, Soil Series No.3, South Australian Health Commission, Adelaide

NEPC publications

NEPC 1999, *National Environment Protection (Assessment of Site Contamination) Measure 1999*, National Environment Protection Council, Canberra

This NEPM consists of a policy framework for the assessment of site contamination in Schedule A (*Recommended General Process for the Assessment of Site Contamination*), while Schedule B has the following guidelines:

- B(1) – Guideline on investigation levels for soil and groundwater
- B(2) – Guideline on data collection, sample design and reporting
- B(3) – Guideline on laboratory analysis of potentially contaminated soils
- B(4) – Guideline on health risk assessment methodology
- B(5) – Guideline on ecological risk assessment
- B(6) – Guideline on risk-based assessment of groundwater contamination
- B(7a) – Guideline on health-based investigation levels
- B(7b) – Guideline on exposure scenarios and exposure settings
- B(8) – Guideline on community consultation and risk communication

- B(9) – Guideline on protection of health and the environment during the assessment of site contamination
- B(10) – Guideline on competencies and acceptance of environmental auditors and related professionals

Other documents

NHMRC & NRMCC 2004, *Guidelines for Drinking Water Quality in Australia*, National Health and Medical Research Council and Natural Resource Management Ministerial Council, Canberra

NSW Agriculture and CMPS&F Environmental 1996, *Guidelines for the Assessment and Clean Up of Cattle Tick Dip Sites for Residential Purposes*, February

APPENDIX XI

Further reading

EPA/DEC documents

DEC 2005, *Information for the Assessment of Former Gasworks Sites*, Department of Environment and Conservation NSW, Sydney, available at www.environment.nsw.gov.au/clm/gasworksassessment.htm

EPA 1997, *Technical Report: Bananalands Contaminant Distribution Study*, NSW Environment Protection Authority, Sydney

ANZECC documents

ANZECC 1994, *Financial Liability for Contaminated Site Remediation: A Position Paper*, Australian and New Zealand Environment and Conservation Council, Canberra

ARMCANZ & ANZECC 1995, *Guidelines for Groundwater Protection in Australia*, Agriculture and Resource Management Council of Australia and New Zealand and Australian and New Zealand Environment and Conservation Council, Canberra

South Australian Health Commission Contaminated Sites monographs

Edwards, J.W., Van Alphen, M. & Langley, A. (eds) 1994, *Identification and Assessment of Contaminated Land: Improving Site History Appraisal*, South Australian Health Commission, Adelaide

El Saadi, O. & Langley, A. (eds) 1991, *Workshop Proceedings of the National Workshop on the Health Risk Assessment and Management of Contaminated Sites*, South Australian Health Commission, Adelaide

Langley, A. 1991, *The Health Risk Assessment and Management of Contaminated Sites*, Contaminated Sites Monograph Series, No.3, South Australian Health Commission, Adelaide

Langley, A., Imray, P. & Hill, H. (eds) 1998, *The Health Risk Assessment and Management of Contaminated Sites, Proceedings of the Fourth National Workshop on the Health Risk Assessment and Management of Contaminated Sites*, Contaminated Sites Monograph Series, No.7, South Australian Health Commission, Adelaide

Langley, A., Markey, B. & Hill, H. (eds) 1996, *The Health Risk Assessment and Management of Contaminated Sites, Proceedings of the Third National Workshop on the Health Risk Assessment and Management of Contaminated Sites*, Contaminated Sites Monograph Series, No.5, South Australian Health Commission, Adelaide

Langley, A. & Van Alphen, M. (eds) 1993, *The Health Risk Assessment and Management of Contaminated Sites, Proceedings of the Second National Workshop on the Health Risk Assessment and Management of Contaminated Sites*, Contaminated Sites Monograph Series, No.2, South Australian Health Commission, Adelaide

Olszowy, H., Torr, P. & Imray, P. 1995, *Trace Element Concentrations in Soils from Rural and Urban Areas of Australia*, Contaminated Sites Monograph Series, No.4, South Australian Health Commission, Adelaide

QA/QC methodologies

American Public Health Association, American Water Works Association & Water Environment Federation 1998, *Standard Methods for the Examination of Water and Wastewater*, 20th edition, Washington DC

Department of Water Resources (NSW) 1992, *A Practical Guide to Groundwater Sampling*, 1st edition, Technical Service Division, Sydney

USEPA 1987, *Data Quality Objectives for Remedial Response Activities*, USEPA 540/G-87/003, United States Environmental Protection Agency Office of Emergency Response and Office of Waste Programs Enforcement, Washington DC

USEPA 1992, *Guidance for Data Useability in Risk Assessment (Parts A and B)*, USEPA 9285.7-09A&B, PB92-963356, United States Environmental Protection Agency Office of Emergency and Remedial Response, Washington DC

USEPA 1992, *Test Methods for Evaluating Solid Waste – Physical/Chemical Methods SW-846*, 3rd Edition, United States Environmental Protection Agency Office of Solid Waste and Emergency Response, Washington DC

USEPA 1993, *Reference Guidance for Planning for Data Collection in Support of Environmental Decision-making Using the Data Quality Objectives Process*, USEPA QA/G-4 United States Environmental Protection Agency Quality Assurance Management Staff, Washington DC

USEPA 1998, *EPAC Guidance for Quality Assurance Project Plans*, EPA/600/R-98/018, United States Environmental Protection Agency Office of Research and Development, Washington DC

USEPA 2000, *Data Quality Objectives Process for Hazardous Waste Site Investigations*, EPA QA/G-4HW Final, Washington DC

USEPA 2000, *Guidance for the Data Quality Objectives Process*, EPAC QA/G-4 DEC/600/R-96/055, United States Environmental Protection Agency Office of Environmental Information, Washington DC

Other documents

ARMCANZ 1997, *Minimum Construction Requirements for Water Bores in Australia*, Agriculture and Resource Management Council of Australia and New Zealand, Canberra

Department of Land and Water Conservation (NSW) 1997, *The NSW State Groundwater Policy Framework Document*, Sydney

Department of Land and Water Conservation (NSW) 1998, *The NSW State Groundwater Quality Protection Policy: A Component Policy of the NSW State Groundwater Policy*, Sydney

Department of Land and Water Conservation (NSW) 2002, *The NSW State Groundwater Dependent Ecosystems Policy: A Component Policy of the NSW State Groundwater Policy*, Sydney

Langley, A., Gilbey, M. & Kennedy, B. (eds) 2003, *Health and Environmental Assessment of Site Contamination*, Proceedings of the Fifth National Workshop on the Assessment of Site Contamination, National Environment Protection Council Service Corporation, Adelaide

Ministry of Housing (Netherlands) 1994, *Environmental Quality Objectives in the Netherlands*, Risk Assessment and Environmental Quality Division, Directorate for Chemicals, External Safety and Radiation Protection, Spatial Planning and the Environment, The Hague

Murray–Darling Basin Commission 1997, *Murray–Darling Basin Groundwater Quality Sampling Guidelines*, Technical Report No.3, Groundwater Working Group, Canberra

USEPA 1989, *Methods for Evaluating the Attainment of Cleanup Standards Volume 1: Soils and Solid Media*, EPA 230/02–89–042, United States Environmental Protection Agency, Washington DC

USEPA 1989, *Risk Assessment Guidance for Superfund, Volume 1: Human Health Evaluation Manual (Part A)*, United States Environmental Protection Agency, Washington DC

USEPA 1991, *Summary Report on Issues in Ecological Risk Assessment*, United States Environmental Protection Agency, Washington DC

USEPA 1998, *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA*, Osver Directive 9355.3–0, United States Environmental Protection Agency Office of Emergency and Remedial Response, Washington DC