Office of Environmental Enforcement

# Guidance On The Management Of Contaminated Land And Groundwater At EPA Licensed Sites

GUIDANCE ON THE MANAGEMENT OF CONTAMINATED LAND AND GROUNDWATER AT EPA LICENSED SITES
Published by the Environmental Protection Agency

**Acknowledgements**
This Guidance Document and associated guideline template reports were prepared with the assistance of Geosyntec Consultants Ltd.

The EPA wishes to acknowledge gratefully all those who provided input to this publication including EPA staff, the Department of Environment, Community and Local Government, stakeholders and all those who made submissions during the consultation processes.

ISBN: 978-1-84095-511-8

07/13/ Web Only
Free of Charge

# ENVIRONMENTAL PROTECTION AGENCY

The Environmental Protection Agency (EPA) is a statutory body responsible for protecting the environment in Ireland. We regulate and police activities that might otherwise cause pollution. We ensure there is solid information on environmental trends so that necessary actions are taken. Our priorities are protecting the Irish environment and ensuring that development is sustainable.

The EPA is an independent public body established in July 1993 under the Environmental Protection Agency Act, 1992. Its sponsor in Government is the Department of the Environment, Community and Local Government.

## OUR RESPONSIBILITIES

### Licensing

We license the following to ensure that their emissions do not endanger human health or harm the environment: waste facilities (e.g., landfills, incinerators, waste transfer stations);

- large scale industrial activities (e.g., pharmaceutical manufacturing, cement manufacturing, power plants);
- intensive agriculture;
- the contained use and controlled release of Genetically Modified Organisms (GMOs);
- large petrol storage facilities;
- waste water discharges;
- dumping at sea.

### National Environmental Enforcement

- Conducting over 1200 audits and inspections of EPA licensed facilities every year.
- Overseeing local authorities' environmental protection responsibilities in the areas of - air, noise, waste, waste-water and water quality.
- Working with local authorities and the Gardaí to stamp out illegal waste activity by co-ordinating a national enforcement network, targeting offenders, conducting investigations and overseeing remediation.
- Prosecuting those who flout environmental law and damage the environment as a result of their actions.

### Monitoring, Analysing and Reporting on the Environment

- Monitoring air quality and the quality of rivers, lakes, tidal waters and ground waters; measuring water levelsand river flows.
- Independent reporting to inform decision making by national and local government.

### Regulating Ireland's Greenhouse Gas Emissions

- Quantifying Ireland's emissions of greenhouse gases in the context of our Kyoto commitments.
- Implementing the Emissions Trading Directive, involving over 100 companies who are major generators of carbon dioxide in Ireland.

### Environmental Research and Development

- Co-ordinating research on environmental issues (including air and water quality, climate change, biodiversity, environmental technologies).

## Strategic Environmental Assessment

Assessing the impact of plans and programmes on the Irish environment (such as waste management and development plans).

## Environmental Planning, Education and Guidance

- Providing guidance to the public and to industry on various environmental topics (including licence applications, waste prevention and environmental regulations).
- Generating greater environmental awareness (through environmental television programmes and primary and secondary schools' resource packs).

## Proactive Waste Management

- Promoting waste prevention and minimisation projects through the co-ordination of the National Waste Prevention Programme, including input into the implementation of Producer Responsibility Initiatives.
- Enforcing Regulations such as Waste Electrical and Electronic Equipment (WEEE) and Restriction of Hazardous Substances (RoHS) and substances that deplete the ozone layer.
- Developing a National Hazardous Waste Management Plan to prevent and manage hazardous waste.

## Management and Structure of the EPA

The organisation is managed by a full time Board, consisting of a Director General and four Directors. The work of the EPA is carried out across four offices:

- Office of Climate, Licensing, Research and Resource Use
- Office of Environmental Enforcement
- Office of Environmental Assessment
- Office of Communications and Corporate Services

The EPA is assisted by an Advisory Committee of twelve members who meet several times a year to discuss issues of concern and offer advice to the Board.

# AN GHNÍOMHAIREACHT UM CHAOMHNÚ COMHSHAOIL

Is í an Gníomhaireacht um Chaomhnú Comhshaoil (EPA) comhlachta reachtúil a chosnaíonn an comhshaol do mhuintir na tíre go léir. Rialaímid agus déanaimid maoirsiú ar ghníomhaíochtaí a d'fhéadfadh truailliú a chruthú murach sin. Cinntímid go bhfuil eolas cruinn ann ar threochtaí comhshaoil ionas go nglactar aon chéim is gá. Is iad na príomh-nithe a bhfuilimid gníomhach leo ná comhshaol na hÉireann a chosaint agus cinntiú go bhfuil forbairt inbhuanaithe.

Is comhlacht poiblí neamhspleách í an Ghníomhaireacht um Chaomhnú Comhshaoil (EPA) a bunaíodh i mí Iúil 1993 faoin Acht fán nGníomhaireacht um Chaomhnú Comhshaoil 1992. Ó thaobh an Rialtais, is í an Roinn Comhshaoil, Pobal agus Rialtais Áitiúil.

# ÁR BHFREAGRACHTAÍ

## Ceadúnú

Bíonn ceadúnais á n-eisiúint againn i gcomhair na nithe seo a leanas chun a chinntiú nach mbíonn astuithe uathu ag cur sláinte an phobail ná an comhshaol i mbaol:

- áiseanna dramhaíola (m.sh., líonadh talún, loisceoirí, stáisiúin aistrithe dramhaíola);
- gníomhaíochtaí tionsclaíocha ar scála mór (m.sh., déantúsaíocht cógaisíochta, déantúsaíocht stroighne, stáisiúin chumhachta);
- diantalmhaíocht;
- úsáid faoi shrian agus scaoileadh smachtaithe Orgánach Géinathraithe (GMO);
- mór-áiseanna stórais peitreail.
- scardadh dramhuisce
- dumpáil mara

## Feidhmiú Comhshaoil Náisiúnta

- Stiúradh os cionn 2,000 iniúchadh agus cigireacht de áiseanna a fuair ceadúnas ón nGníomhaireacht gach bliain.
- Maoirsiú freagrachtaí cosanta comhshaoil údarás áitiúla thar sé earnáil - aer, fuaim, dramhaíl, dramhuisce agus caighdeán uisce.
- Obair le húdaráis áitiúla agus leis na Gardaí chun stop a chur le gníomhaíocht mhídhleathach dramhaíola trí comhordú a dhéanamh ar líonra forfheidhmithe náisiúnta, díriú isteach ar chiontóirí, stiúradh fiosrúcháin agus maoirsiú leigheas na bhfadhbanna.
- An dlí a chur orthu siúd a bhriseann dlí comhshaoil agus a dhéanann dochar
- don chomhshaol mar thoradh ar a ngníomhaíochtaí.

## Monatóireacht, Anailís agus Tuairisciú ar an gComhshaol

- Monatóireacht ar chaighdeán aeir agus caighdeáin aibhneacha, locha, uiscí taoide agus uiscí talaimh; leibhéil agus sruth aibhneacha a thomhas.
- Tuairisciú neamhspleách chun cabhrú le rialtais náisiúnta agus áitiúla cinntí a dhéanamh.

## Rialú Astuithe Gáis Ceaptha Teasa Na hÉireann

- Cainníochtú astuithe gáis ceaptha teasa na hÉireann i gcomhthéacs ár dtiomantas Kyoto.
- Cur i bhfeidhm na Treorach um Thrádáil Astuithe, a bhfuil baint aige le hos cionn 100 cuideachta atá ina mór-ghineadóirí dé-ocsaíd charbóin in Éirinn.

## Taighde Agus Forbairt Comhshaoil

- Taighde ar shaincheisteanna comhshaoil a chomhordú (cosúil le caighdéan aeir agus uisce, athrú aeráide, bithéagsúlacht, teicneolaíochtaí comhshaoil).

## Measúnú Straitéiseach Comhshaoil

- Ag déanamh measúnú ar thionchar phleananna agus chláracha ar chomhshaol na hÉireann (cosúil le pleananna bainistíochta dramhaíola agus forbartha).

## Pleanáil, Oideachas agus Treoir Chomhshaoil

- Treoir a thabhairt don phobal agus do thionscal ar cheisteanna comhshaoil éagsúla (m.sh., iarratais ar cheadúnais, seachaint dramhaíola agus rialacháin chomhshaoil).
- Eolas níos fearr ar an gcomhshaol a scaipeadh (trí cláracha teilifíse comhshaoil agus pacáistí acmhainne do bhunscoileanna agus do mheánscoileanna).

## Bainistíocht Dramhaíola Fhorghníomhach

- Cur chun cinn seachaint agus laghdú dramhaíola trí chomhordú An Chláir Náisiúnta um Chosc Dramhaíola, lena n-áirítear cur i bhfeidhm na dTionscnamh Freagrachta Táirgeoirí.
- Cur i bhfeidhm Rialachán ar nós na treoracha maidir le Trealamh Leictreach agus Leictreonach Caite agus le Srianadh Substaintí Guaiseacha agus substaintí a dhéanann ídiú ar an gcrios ózóin.
- Plean Náisiúnta Bainistíochta um Dramhaíl Ghuaiseach a fhorbairt chun dramhaíl ghuaiseach a sheachaint agus a bhainistiú.

## Struchtúr Na Gníomhaireachta

Bunaíodh an Ghníomhaireacht i 1993 chun comhshaol na hÉireann a chosaint. Tá an eagraíocht á bhainistiú ag Bord lánaimseartha, ar a bhfuil Príomhstiúrthóir agus ceithre Stiúrthóir.
Tá obair na Gníomhaireachta ar siúl trí ceithre Oifig:

- An Oifig Aeráide, Ceadúnaithe, Taighde agus Úsáide Acmhainní
- An Oifig um Fhorfheidhmiúchán Comhshaoil
- An Oifig um Measúnacht Comhshaoil
- An Oifig Cumarsáide agus Seirbhísí Corparáide

Tá Coiste Comhairleach ag an nGníomhaireacht le cabhrú léi. Tá dáréag ball air agus tagann siad le chéile cúpla uair in aghaidh na bliana le plé a dhéanamh ar cheisteanna ar ábhar imní iad agus le comhairle a thabhairt don Bhord.

# Table Of Contents

# 1. INTRODUCTION

This document sets out the EPA's position in relation to the management of contaminated land and groundwater at EPA licensed sites. The approach outlined here may also be suitable for the purposes of assessing Land Damage at sites under the Environmental Liability Regulations (S.I. 547 of 2008).[1] The principal aim in dealing with contaminated land and groundwater related issues is to secure the protection of human health, water bodies (including groundwater) and the wider environment.

Currently there is no specific legislation addressing contaminated land in Ireland and to date numerous approaches to the problem, including the ad hoc application of standards and methodologies from other countries, have been applied. These approaches are frequently applied inappropriately, resulting both in the EPA not being in a position to take risk–based decisions to progress issues and in operators expending resources without progressing towards a solution.

This guidance document and associated guideline template reports went out to public consultation in 2012 and have been finalised following consideration of the issues raised during that consultation process.

The risk based approach in this guidance is considered best practice for the assessment and remediation of contaminated land and groundwater at EPA licensed sites. This consistent approach will ensure that the standard of works undertaken is adequate, that issues are understood and dealt with appropriately and that both operators and the EPA achieve the aim of closing issues out in an efficient manner.

In order for the assessment process to work, there is a need for the collection of reliable data by suitably qualified and experienced personnel, based on a good-quality Conceptual Site Model (CSM). The strategy behind a sampling and monitoring programme needs to be clear, logical and well planned out. The investigation and/or monitoring exercise to collect the data must follow good practice in all respects. This typically can only be assured if the professional staff involved are suitably qualified and experienced, which for groundwater-related work usually requires a hydrogeologist to be an active member of the project team.

Under existing EPA licenses, new releases of contaminants to land and groundwater are controlled. If an unauthorised discharge occurs to land and groundwater, then it should be reported to the EPA immediately or as soon as it is first identified (via, for example, routine monitoring). The licensee should address the release quickly with prompt, suitable corrective action agreed by the EPA.

Sections 2–5 of this document describe the stages of the risk assessment methodology, guideline template reports and risk assessment tools and standards. Technical terms used in the guidance are defined in Section 6. References to useful technical and best practice guidance are included in Section 7.

This guidance is a live document and will be updated periodically to reflect changes in legislation, technical guidance and industry best practice.

The current CODE OF PRACTICE: Environmental Risk Assessment for Unregulated Waste Disposal Sites (EPA, 2007)[2] and associated guidance should continue to be used when assessing unregulated historic landfills.

1. Environmental Liability Regulations (S.I. 547 of 2008) http://www.attorneygeneral.ie/esi/2008/B26632.pdf
2. CODE OF PRACTICE: Environmental Risk Assessment for Unregulated Waste Disposal Sites (EPA, 2007) http://www.epa.ie/pubs/advice/waste/waste/codeofpracticeenvironmentalriskassessmentforunregulatedwastedisposalsites.html

# 2. OUTLINE OF RISK BASED APPROACH

Risk-based assessment of known or suspected contaminated land and groundwater issues is considered to be best practice and is a requirement under the Environmental Liability Regulations.

A risk based process must be used consistently so that land and groundwater contamination issues at sites are understood to a sufficient degree to allow decision making to take place and regulatory acceptance of proposed decisions and/or Corrective Action.

Figure 1 illustrates the overall risk assessment methodology. This approach is broadly in line with the EPA's *CODE OF PRACTICE: Environmental Risk Assessment for Unregulated Waste Disposal Sites* (2007) (referred to herein as "COP") and the UK Environment Agency's (UKEA) document *Model Procedures for the Management of Land Contamination: Contaminated Land Report No.11*[3] (commonly known as "CLR 11"). The approach is designed to be better suited to EPA licensed sites and to allow more focused and consistent decision-making. This is because at licensed sites there is more site-specific information available than at typical brownfield redevelopment sites, which have been the focus of CLR 11 design and use in the UK. The EPA approach more explicitly highlights and deals with land and groundwater issues, rather than just soil contamination. All stages of the process should be undertaken by appropriately qualified and experienced professionals.

Both the EPA COP and the CLR 11 are key reference documents and should be consulted as indicated in this guidance. The risk assessment methodology follows a staged approach, designed to ensure that key elements are addressed in succession and only as needed. The three main stages are (see Figure 1):

- STAGE 1: Site Characterisation & Assessment
- STAGE 2: Corrective Action Feasibility & Design
- STAGE 3: Corrective Action Implementation & Aftercare.

The licensee/operator can enter the process at any stage, such that past programmes of assessment or remedial works can be transferred into the staged approach. This is contingent on the data and information available from past work being relevant and reliable and to the satisfaction of the EPA. Similarly, a licensee/operator has the ability to close out the process and finish land- and groundwater-related assessment or action at any stage subject to the agreement of the EPA.

3. Model Procedures for the Management of Land Contamination. UK Environment Agency Contaminated Land Report No. 11 http://publications.environment-agency.gov.uk/pdf/SCHO0804BIBR-e-e.pdf

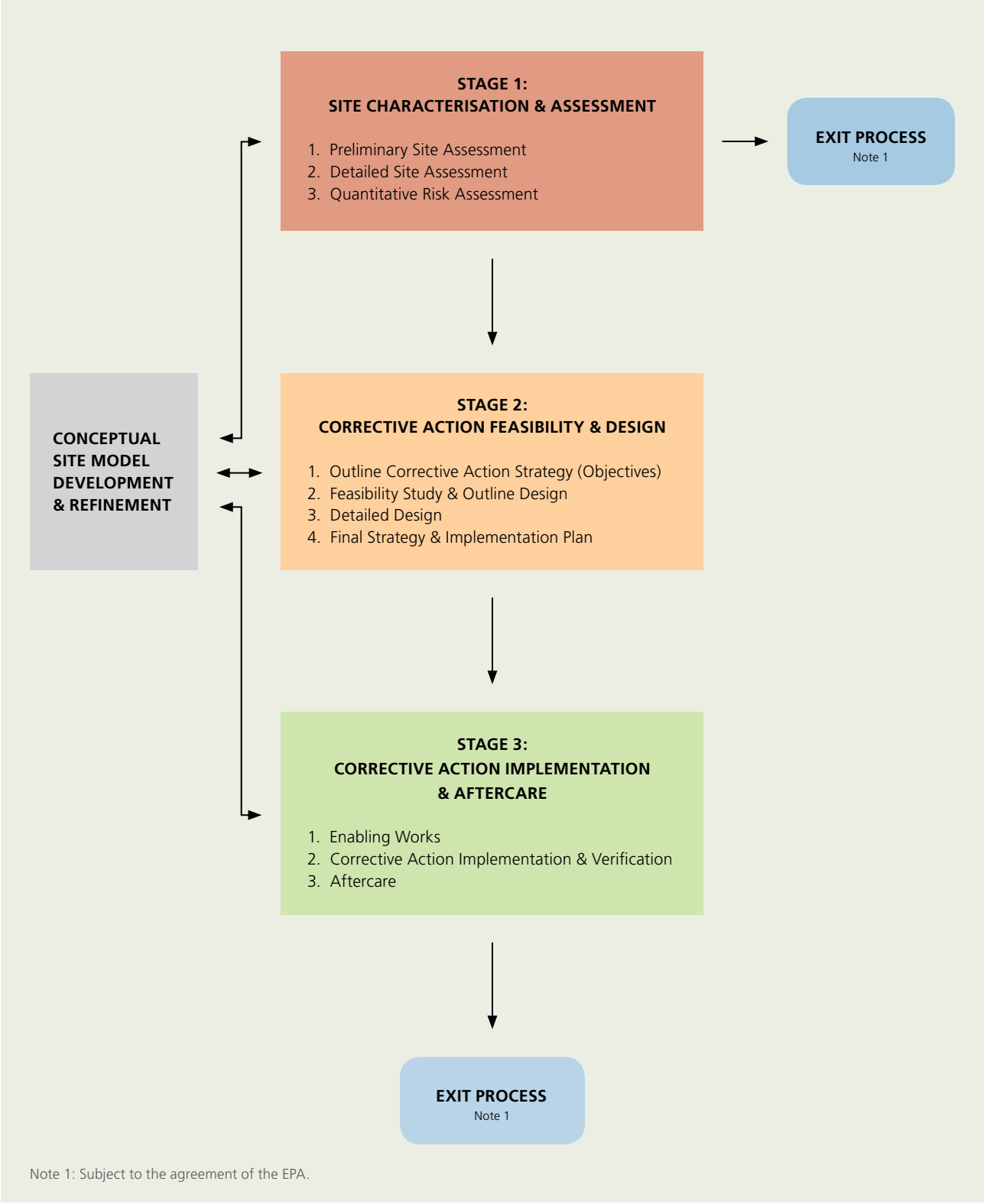


**Figure 1. EPA Contaminated Land & Groundwater Risk Assessment Methodology**

# CONCEPTUAL SITE MODEL

A critical element of the methodology and something that underpins the whole process is the establishment and use of a Conceptual Site Model (CSM) for the land and groundwater environment. The CSM is produced at Step 1 – Preliminary Site Assessment and is then updated, based on additional information and data, throughout the whole process (Stages 1–3). Guidance on the development and use of CSMs is provided in Chapter 3 of the COP (EPA, 2007)

Diagrammatic CSMs are the preferred model and should always be used (Figure 2 contains an example of a diagrammatic CSM). Well-constructed matrices and network diagrams may also be effective, particularly in the latter stages of the process when attention is focused on specific and determined pollutant linkages.

The CSM describes the potential sources of contamination at a site, the migration pathways it may follow and the receptors it could impact upon. Potential receptors to land and groundwater contamination might include (but are not exclusive to) humans, water resources, groundwater/surface water dependent ecosystems and living organisms. If complete source–pathway–receptor scenarios exist then there is a potential pollutant linkage that needs to be characterised and assessed (via formal risk assessment). The failure to have an appropriate CSM is one of the key reasons why many contaminated land & groundwater reports fail to achieve the objective of targeting the main potential issues of concern and fail to achieve a suitable level of understanding and closeout for the site in an efficient manner.


**Figure 2. Example of a Diagrammatic Conceptual Site Model (CSM)**

# 3. STAGES OF METHODOLOGY

## 3.1 STAGE 1: SITE CHARACTERISATION & ASSESSMENT

Stage 1 involves gathering key data and undertaking a comprehensive investigation and assessment of the site. It is split into three steps:

1.1 Preliminary Site Assessment,
1.2 Detailed Site Assessment and
1.3 Quantitative Risk Assessment (QRA) - firstly Generic QRA and then Detailed QRA.

Technical summaries of activities and data requirements for Stage 1 are provided in key technical guidance documents.[4]

Many sites will already have some data and undertake a level of groundwater (and possibly surface water) monitoring that is reported annually to the EPA as part of their Annual Environmental Report (AER). However, it is important to ensure that the sampling and analysis and subsequent interpretation of results is undertaken correctly and the scope of works completed is appropriate for the scale of operations at the site in question.[5] Suitable existing site data should form part of the CSM development and assessment required in Stage 1.

The CSM is first developed as part of the Step 1 Preliminary Site Assessment. The start of more formal risk assessment follows completion of Step 2 Detailed Site Assessment. The main phase of quantitative risk assessment progresses through Generic Quantitative Risk Assessment (GQRA) to Detailed Quantitative Risk Assessment (DQRA).

GQRA makes use of Generic Assessment Criteria (GAC) (see Section 4 for further details) to identify Pollutant Linkages for which DQRA should be undertaken. The DQRA should also be used to identify the requirement for Corrective Action, to determine verification criteria with which to assess the effectiveness of Corrective Action, and ultimately to validate that the Corrective Action has been completed successfully. Following the completion of the QRA, an evaluation of the overall risk of the site to the environment should be made.

## 3.2 STAGE 2: CORRECTIVE ACTION FEASIBILITY & DESIGN

If Stage 1 identifies problem areas at a site that need to be addressed, then the process moves to Stage 2, where the feasibility of Corrective Action options are considered and a design/plan for Corrective Action determined. Corrective Actions can comprise a programme ranging from Monitored Natural Attenuation (MNA) to the need for extensive site works and installation and management of treatment systems (active remediation). This feasibility and design stage provides a decision-making tool for what is the most appropriate site solution. Technical summaries of Stage 2 activities and considerations are presented in other key technical guidance documents.[6]

Justification for the selected approaches should be undertaken on the basis of practicability, likelihood of success in achieving the remedial objectives, cost, timescale and sustainability.

4. Refer to COP (EPA, 2007) Chapters 4, 5 and 6 and CLR 11 Part 1 Chapter 2.
5. Refer to COP (EPA, 2007) Chapter 5 and BS10175:2011
6. Refer to COP (EPA, 2007) Chapter 7 and CLR 11 Part 1 Chapter 3.

## 3.3 STAGE 3: CORRECTIVE ACTION IMPLEMENTATION & AFTERCARE

The implementation of the Corrective Action scheme designed at Stage 2 is undertaken in Stage 3 with a critical element being verification that the corrective action strategy is achieving its aims.[7] For those sites that require Stage 3 action, the risk assessment methodology will allow for sign-off and closeout, or the management of an issue in the long term, as well as the opportunity to review the actions taken, their appropriateness and their efficiency in achieving the desired environmental outcome.

The time taken to progress through the three main stages will very much be based on site-specific circumstances. However, it is considered reasonable to assume that the following timeframes for completion of key stages will broadly apply in most cases:

- Stage 1: Normally 3–18 months
- Stage 2: 6–12 months (if needed)
- Stage 3: Typically a number of years (if needed).

7. Refer to CLR 11 Part 1 Chapter 4.

# 4. RECOMMENDED SOIL & GROUNDWATER STANDARDS & RISK ASSESSMENT TOOLS

The sole use of soil or groundwater Generic Assessment Criteria (GAC) for the risk assessment of sites and/or verification of Corrective Action is not recommended. GAC represent concentrations below which impact on receptors (human health, water-dependent ecosystems, etc.) is very unlikely and they are useful for initial screening purposes. Soil and/or groundwater concentrations that are found to exceed GAC (from the GQRA) are an indication of potential risk to receptors and therefore this requires a DQRA to be undertaken.

Each contaminated site must be assessed on the level of risk it poses to the environment and the Corrective Action required will be driven by this. Numerous international soil standards have been applied in Ireland to date and their use for Corrective Action decision making has often led to poor outcomes.

With respect to soil, the screening levels that can be used (GAC) have been derived for two main receptor scenarios, human health and potential for impact on groundwater via leaching.

For human health, the EPA recommends the use of GAC, based on the UKEA Contaminated Land Exposure Assessment (CLEA)[8] model, either produced by the UKEA itself (known as Soil Guideline Values/SGVs) or values generated using the CLEA model by reputable third-party organisations such as Land Quality Management (LQM)[9] or Contaminated Land: Applications in Real Environments (CL:AIRE).[10] Where GAC have not been published or if practitioners don't use human health GAC publications, values should be generated by appropriately qualified and experienced professionals using the CLEA model to ensure consistency with the EPA approach. For soil GACs linked to potential impact on groundwater due to leaching, simple partitioning modelling is used to generate acceptable soil concentrations associated with acceptable pore water concentrations.

The naturally occurring background levels of some contaminants in Ireland, for example metals, may exceed GAC based on the CLEA model.[11] Background levels of contaminants should be considered in risk assessment and the methodology published by the UK Department for Environment, Food and Rural Affairs (DEFRA) and the British Geological Survey[12] may be a useful reference. Soil concentrations that are typical of naturally occurring background levels (as indicated in Irish published sources including the Irish National Soil Database[13] and SURGE Report[14]) should not be considered as risk-driving or as indicating land damage. For concentrations exceeding typical background levels, further detailed site investigation and DQRA will be required to assess whether site concentrations represent locally elevated but widespread and commonplace background levels or whether concentrations are from anthropogenic origin and represent increased risk to receptors.

Values for screening of the impact on groundwater may come from several sources, including the European Communities Environmental Objectives (Groundwater) Regulations 2010 (S.I. no. 9 of 2010),[15] the EPA's Groundwater Threshold Values (GTVs),[16] the EPA's Interim Guideline Values (IGVs)[17] or relevant Environmental Quality Standards (EQSs), when considering a surface water receptor.

GAC values have a role to play in initially screening data from site investigations. They allow the magnitude of reported contamination to be put in context, and help screen out concentrations that are not elevated from those that are. This provides a short list of contaminants/chemicals of potential concern (COPC), whether in soil, groundwater or surface water, that will be required to be taken forward for DQRA.

8. http://www.environment-agency.gov.uk/research/planning/64000.aspx
9. LQM/CIEH Generic Assessment Criteria for Human Health Risk Assessment 2nd Ed. http://www.lqm.co.uk/pages/gac.html
10. CL:AIRE (2010) Soil Generic Assessment Criteria for Human Health Risk Assessment http://www.claire.co.uk/index.php?option=com_phocadownload&view=file&id=44:Other-CLAIRE-Documents&Itemid=91
11. This issue is shared by the UK also with respect to arsenic, lead and benzo[a]pyrene amongst other common contaminants.
12. Establishing data on background levels of contamination – SP1008 http://randd.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&ProjectID=17768&FromSearch=Y&Publisher=1&SearchText=sp1008&SortString=ProjectCode&SortOrder=Asc&Paging=10#Description
13. EPA The Irish National Soils Database http://erc.epa.ie/nsdb/
14. Geological Survey of Ireland http://www.gsi.ie/Surge.htm
15. European Communities Environmental Objectives (Groundwater) Regulations 2010 (S.I. no. 9 of 2010) http://www.environ.ie/en/Legislation/Environment/Water/FileDownLoad,22163,en.pdf
16. Methodology for Establishing Groundwater Threshold Values, the Assessment of Chemical and Quantitative Status for Groundwater and Groundwater Trends (EPA, 2010) http://www.epa.ie/pubs/reports/water/ground/groundwaterthresholdvaluesandassessmentofchemicalandquantitativestatus.html
17. Towards Setting Guideline Values For The Protection Of Groundwater In Ireland – Interim Report http://www.epa.ie/pubs/advice/water/ground/towardssettingguidelinevaluesfortheprotectionofgroundwaterinireland.html

The Water Framework Directive objectives for any groundwater or surface water body will also be a key issue to be considered when assessing the risk posed to the environment by a site. The EPA's 2011 *Guidance on the Authorisation of Discharges to Groundwater*[18] should also be considered when assessing impact or potential impacts on groundwater resources.

Groundwater generic screening values such as IGVs and GTVs can be used for two main applications, as follows:

- they can be used for initial screening of site investigation data, designed to initially prioritise contaminants/ chemicals of potential concern (COPC) and carry them forward within the overall assessment process; and
- they can be used directly as acceptable groundwater concentrations at down gradient, site-specific compliance point(s) defined in the Conceptual Site Model (CSM) and site-specific DQRA.

The EPA also recommends that where risk assessment modelling is required, models which have been benchmarked by the UK Environment Agency as part of CLR 11 are used. Many of these products are already in wide use by consultants (Remedial Targets Methodology (RTM), RBCA, RISC, RAM, ModFlow, etc.).

It should be noted that risk assessment tools and models should only be used by suitably qualified/experienced practitioners and should be selected and deployed with careful consideration to Ireland's specific geology and hydrogeology. Justification should be provided and agreement obtained from the EPA prior to any model being used. For some sites, a combination of modelling and on- and off-site data gathering and monitoring may be required. It should be noted that in some cases, modelling may not be appropriate at all. Such decision-making should ensure that risks are assessed in a consistent and meaningful way and that the environment is protected.

18. Guidance on the Authorisation of Discharges to Groundwater http://www.epa.ie/pubs/reports/water/ground/dischgw/

# 5. GUIDELINE TEMPLATE REPORTS

At every key stage of the process it is critical that formal written reports are prepared and retained. These reports must cover the basis for all important decisions made and are required to provide the necessary assurances that each stage of the process has been undertaken with the required degree of rigour.

In order to assist operators and/or their consultants with the preparation of suitable reports to address the various stages and sub-tasks within the land and groundwater risk assessment methodology, a series of guideline template reports have been produced that set out the content and standard of work that should be achieved. These are available on the EPA website for download at www.epa.ie and should be used by all licensees when submitting reports to the EPA.

The reports set out what stage a site is at so that operators can see what part of the process they are currently in.

Templates have been prepared for the following stages:

| | |
|---|---|
| **STAGE 1** | Preliminary Site Assessment Report<br>Detailed Site Assessment Report<br>Quantitative Risk Assessment Report |
| **STAGE 2** | Corrective Action Feasibility & Design Report |
| **STAGE 3** | Construction Phase/Enabling Works Report<br>Corrective Action Implementation & Verification (Aftercare) Report |

A guideline template report for Groundwater Monitoring has also been developed and is available on the EPA website. This report will commonly be needed in parallel with other Stages 1-3 process deliverables.

# 6. GLOSSARY

**Note: The list of terms below is intended to assist understanding of this document and does not purport to be a legal interpretation of said terms.**

**Aquifer**
A subsurface layer or layers of rock or other geological strata of sufficient porosity and permeability to allow either a significant flow of groundwater or the abstraction of significant quantities of groundwater.

**CLEA (Contaminated Land Exposure Assessment)**
The UK's Environment Agency recommended methodology for the assessment of chronic risk to human health from contaminants in soil.

**CLR 11**
The UK's recommended overarching framework for the investigation, assessment and remediation of land contamination.

**Compliance Point**
The point (location, depth) at which a compliance value should be met. Generally it is represented by a borehole or monitoring well from which representative groundwater samples can be obtained.

**Conceptual Site Model (CSM)**
A simplified representation or working description of how a real system is believed to behave on the basis of assessment of field data including the relationships between contaminants, pathways and receptors. More complex conceptual site models may include preliminary calculations of water balances, contaminant fate, etc.

**ConSim**
Hydrogeological risk assessment software developed by Golder Associates that implements the Remedial Targets Methodology. ConSim includes probabilistic functionality and unsaturated transport models that distinguish it from the Remedial Targets Worksheet.

**Contaminant (Source)**
A substance that is in, on or under the land and that has the potential to adversely affect health or to cause pollution of the wider environment.

**Contaminated Land and Groundwater**
Any land or groundwater impacted by contamination.

**COPC**
Contaminants or Chemicals of Potential Concern.

**Corrective Action**
Additional assessment (e.g. Detailed Quantitative Risk Assessment), management strategy and/or remediation to mitigate the effects of unacceptable risks to sensitive receptors.

**Detailed Quantitative Risk Assessment (DQRA)**
Risk assessment carried out using detailed, site-specific information to estimate risk or to develop site-specific assessment criteria.

**Down-gradient**
The direction of decreasing groundwater levels, i.e. flow direction. Opposite of up-gradient.

**Environment Agency (EA)**
UK Environment Agency.

**Generic Assessment Criteria (GAC)**
Criteria derived using generic assumptions about the characteristics and behaviour of contaminants (sources), pathways and receptors. These assumptions will be protective in a range of defined conditions, e.g. Interim Guideline Values (IGVs).

**Generic Quantitative Risk Assessment (GQRA)**
Risk assessment carried out using generic assumptions to estimate risk or to develop generic assessment criteria.

**Groundwater**
All water which is below the surface of the ground in the saturation zone and in direct contact with the ground or subsoil. The EPA interpretation of the settings in which groundwater can occur is presented in Section 3.2.1 of Guidance on the Authorisation of Discharges to Groundwater (EPA, 2011).

**Groundwater Resource**
An aquifer capable of providing a groundwater supply of more than 10 m3 a day as an average or serving more than 50 persons.

**GTV**
Groundwater Threshold Value.

**Integrated Pollution Prevention and Control Licence (IPPC)**
A licence for industrial and other activities issued by the EPA under the Environmental Protection Agency Acts, 1992 as amended.

**Interim Guideline Values (IGVs)**
Generic assessment criteria protective of potable water supplies and the aquatic environment.

**Land Damage**
Any contamination that creates a significant risk of human health being adversely affected as a result of the direct or indirect introduction in or under the land of substances, preparations, organisms or micro-organisms.

**Leaching Potential**
Ability for a substance to dissolve in pore water and migrate.

**Model**
Mathematical representation of elements of a Conceptual Site Model often through the use of proprietary or commercially available software incorporating a selection of specific Tools.

**Modelling**
Means of testing and developing Conceptual Site Models concerning the migration of or exposure to contaminants.

**Partitioning/ Partitioning Modelling**
Partitioning is the process by which a contaminant, released originally in one phase (e.g. adsorbed to soil grains) becomes distributed between other phases (i.e. vapour and dissolved phases). Partitioning Modelling is the estimation of the distribution of contaminant concentration between different geochemical phases (e.g. the concentration in the dissolved phase).

**Pathway**
The route which a particle of water and/or chemical or biological substance takes through the environment from a source to a receptor location. Pathways are determined by natural hydrogeological characteristics, but can also be influenced by the presence of features resulting from human activities (e.g. abandoned, ungrouted boreholes which can direct surface water and associated pollutants preferentially to groundwater).

**Pollutant Linkage**
The relationship between a contaminant (source), pathway and receptor. Also known as Source-Pathway-Receptor linkage or S-P-R.

**Pore Water**
Water that occupies void spaces between mineral grains in unlithified (uncemented) sediments.

**Preliminary Site Assessment**
First step of Stage 1 Site Characterisation & Assessment, the aims being to develop an initial conceptual site model, establish whether or not there are any potentially unacceptable risks and the rationale for the scope of detailed site investigation.

**Probabilistic/Stochastic Modelling**
The use of mathematical distributions (e.g. normal, log-normal) to account for the variability/uncertainty in modelled parameters to produce a range of resultant values. While it requires significantly more data and conceptual understanding to develop than deterministic models, the outcome of probabilistic modelling can be less conservative, and more realistic, which may influence decision-making.

**RAM**
Hydrogeological risk assessment software developed by ESI Ltd that implements the Remedial Targets Methodology. It is possible to construct intricate Pollutant Linkages with complex water balances, which sets it apart from some other proprietary and commercial available software.

**RBCA ToolKit**
Commercially available human health and hydrogeological risk assessment software that implements ASTM's Risk Based Corrective Action framework. RBCA ToolKit has been benchmarked in the UK.

**Receptor**
Something that could be adversely affected by a contaminant, e.g. people, a water body (groundwater or surface water), living organism, property or an ecological system. A groundwater receptor could include existing and potential future drinking water supplies, surface water bodies into which groundwater discharges (e.g. streams) and groundwater dependent terrestrial ecosystems (GWDTEs).

**Remedial Targets Methodology (RTM)**
The UK's recommended approach for undertaking hydrogeological risk assessment for contaminated land and deriving soil and groundwater remedial targets for the aquatic environment.

**Remedial Targets Worksheet**
Spreadsheet-based tool developed by the Environment Agency that implements the Remedial Targets Methodology.

**Remediation**
Action taken to prevent or minimise, remedy or mitigate the effects of any identified unacceptable risks.

**Remediation Criteria**
Measures (usually, but not necessarily, expressed in quantitative terms) against which compliance with remediation objectives will be assessed.

**Remediation Objective**
A site-specific objective that relates solely to the reduction or control of risks associated with one or more pollutant linkages.

**Remediation Option**
A method or technology that could be applied at a site to reduce or control the risks associated with a particular pollutant linkage.

**Remediation Strategy**
A plan that involves one or more remediation options to reduce or control the risks from all the relevant pollutant linkages associated with a site.

**RISC**
Commercially available human health, hydrogeological and ecological risk assessment software that implements ASTM's Risk Based Corrective Action framework. RISC, formerly BP RISC, incorporates probabilistic functionality and has been benchmarked for use in the UK.

**Site**
For the purposes of this guidance document, the term 'site' refers to any EPA licensed site, facility, installation and/or activity.

**Site Characterisation**
Main stage of intrusive investigations which could involve the collection and analysis of soil, surface water, groundwater, soil gas and/or other media as a means of further informing the conceptual model and risk assessment.

**Soil**
The top layer of the Earth's crust situated between the bedrock and the surface. The soil is composed of mineral particles, organic matter, water, air and living organisms.

**Soil Pore Water**
Water that occupies void spaces between mineral grains and particles in unlithified (uncemented) sediments in the Unsaturated Zone.

**Surface Water**
An element of water on the land's surface such as a lake, reservoir, stream, river or canal. Can also be part of transitional or coastal waters.

**Surface Water Bodies**
Inland waters, except groundwater, which are on the land surface (such as reservoirs, lakes, rivers, transitional waters, coastal waters and, under some circumstances, territorial waters) which occur within a Water Framework Directive river basin district.

**Tool**
Mathematical calculator or equations used to define or evaluate an element of a Conceptual Site Model.

**Verification**
The process of demonstrating that the risk has been reduced to meet remediation criteria and objectives based on a quantitative assessment of remediation performance. The term "verification" is often used interchangeably with "validation" in contaminated land guidance and in practice.

**Waste Management Licence**
A licence for activities in the waste sector given by the EPA under the Waste Management Acts, 1996 as amended.

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