# CHAPTER 2

# Historic Mine Sites – Inventory and Risk Classification Scoring System

## 2.1 Methodology overview

The purpose of this chapter is to provide an overview of the methodology used in the project in relation to the following areas of work:

1. Preliminary screening and site selection for the historic mine sites included in this investigation;
2. Conceptual model; and
3. Risk ranking and classification.

A more detailed description of these work areas is given in the Appendices to this report, which are referenced at specific parts of the report.

## 2.2 Preliminary screening and site selection

Two-hundred and twenty mine sites were located across the country from which there has been extraction of minerals using the GSI databases. Expert judgment was then applied to the existing databases to extract a list of sites that should be included in the risk ranking and classification work. Detailed knowledge on mining history, mining methods, mineral processing, geology and mineralisation, coupled with assessment criteria, such as scale, elements present (Pb, Zn, Cu, Ni, As, Cd, Hg), ARD/AMD potential, principal sources of polluting materials present (tailing impoundments, processing wastes, rock waste dumps, etc.) and environmental setting, was used to carry out a preliminary screening of the sites.

A desk-top study carried out by Eamonn Grennan, Sligo Institute of Technology, in 1996 for the EPA which used a combination of expert judgement and assessment criteria to derive a pollution index potential for 128 mine sites across the country was used in the preliminary screening (Grennan, 1996). This work assigned a potential Pollution Index Number (PIN) from 1 to 9 to the 128 sites. PIN 1 sites included all recently closed large-scale base-metal mines (closed in the 1980s) and major coalfields where significant volumes of waste are present and the ARD/AMD potential is high. Table 2.1 provides a summary of the PIN codes, the number of mines included within a particular code and a general description of the mines included in the code.

| Pollution Index No. | Number of Sites | Main Assessment Criteria Used |
|---|---|---|
| 1 | 10 | Recently closed, large-scale metal mines and coalfields, processing chemical(s) used, presence of tailing impoundments, high ARD/AMD potential |
| 2 | 14 | Medium sized sites (>100,000 tpa production or 100 persons employed), usually worked prior to 1960 and/or satellite deposits associated with larger mines. They may also contain particularly toxic elements such as Cd and As |
| 3 | 16 | Coalfields and smaller metal mines and industrial mines. AMD thought to be significant. Smaller than PIN 2 sites. Includes sites with a high S content. This is generally the highest class for coalfield sites. |
| 4 | 20 | Non-toxic suspended solids presenting a major problem to surface waters. Highest class for slate, associated metal mines working, generally small scale. |
| 5 | 14 | Older, long-abandoned mines, insufficient information to classify with any degree of certainty, further investigations required. |
| 6 | 21 | Small working scattered over large areas, possible groundwater issues |
| 7 | 11 | Industrial mineral workings that are old and small and include very small metalliferous mines located inland. |
| 8 | 15 | Small coastal metalliferous mines |
| 9 | 7 | Very small and very old, no significant metals, located along cliff edges. |

Table 2.1 Assessment criteria and pollution index number for mine sites.

The preliminary screening and site selection process identified 110 individual mine sites for investigation in the HMS-IRC project. Many of these sites can be grouped into mining ***districts*** in which numerous sites share metallogenic and geochemical features. Additionally, sites within mining districts were typically exploited simultaneously and may have shared processing facilities. Their proximity to one another means that they are likely to have an impact on the same environmental receptors, e.g. surface watercourses or groundwater aquifers. Thus, where justified by proximity and shared development history, sites have been grouped into districts and the districts have been treated as individual entities for scoring purposes. Where sites assigned to the same district are physically separate and do not share potential receptors, they have been scored separately. Stand-alone sites, e.g. Tynagh, are considered to be a district in themselves for classification purposes.

The mine sites in the Glendalough–Glendasan–Glenmalure area provide an example of this district classification process. Geologically and geochemically, all the sites in this area can be considered to be part of a single district — the Glendalough District — and they are treated as such for descriptive purposes and in the overall geochemical assessment. However, while the sites in Glendalough and Glendasan were exploited by a single company, used shared processing facilities and are in close proximity to one another, those in Glenmalure are physically separated from the others and were exploited independently. Potential receptors affected by environmental contamination in Glendalough–Glendasan and Glenmalure are entirely different. Thus, instead of grouping all sites into just one district for scoring purposes, the individual sites in both Glendalough–Glendasan and in Glenmalure are grouped into two districts, according to the logic outlined above. Similarly, Ballyvergin, Ballyhickey and Kilbricken have been grouped into the Clare Lead District but, because they are physically separate sites, they have been scored individually.

All sites in the country have been assigned to a mine district in a similar way. Table 2.2 lists those districts and sites that have been investigated for the HMS-IRC project. Not all districts or sites visited and investigated were subjected to geochemical assessment and subsequent classification using the HMS-IRC scoring system (geochemistry). Of the 32 districts or sites listed in Table 2.2, five were not scored: Crohy Head, Kanturk, Killaloe, Redhills and Ross Island. The nine sites in the Killaloe slate quarries district have large volumes of waste but analysis indicates that it contained no elements of concern from an environmental perspective. Crohy Head is a talc mine and, as such, had no waste of chemical concern. Kanturk and Redhills both lacked significant exposed waste. Ross Island is now a managed heritage site and contains only very minor amounts of solid waste. Both Killaloe and Kanturk have significant geotechnical features and are included in the HMS-IRC geotechnical assessment. In addition to the above five, seven sites in the West Cork Copper–Barium District (Ardagh, Ballydehob, Cappagh, Derreennamolane, Derryginagh, Roaring Water and Scart), one site in the Clare Phosphate District (Noughaval), and two in Connemara (Tiernakill and Doorus) were not scored because they lacked mine waste. The 27 districts or sites scored listed in Table 2.2 include a total of 82 individual mine sites that were geochemically assessed and scored using the HMS-IRC scoring system.

| Name | Mine District | No. of Sites | Sites Classified | Commodity(ies) Extracted |
|---|---|---|---|---|
| Abbeytown | Abbeytown | 1 | ✓ | Pb, Zn |
| Allihies | Allihies | 6 | ✓ | Cu |
| Avoca | Avoca | 7 | ✓ | Cu, pyrite |
| Ballycorus | Ballycorus | 1 | ✓ | Pb |
| Ballyhickey | Clare Pb | 1 | ✓ | Pb |
| Ballyvergin | Clare Pb | 1 | ✓ | Pb |
| Benbulben | Benbulben | 1 | ✓ | Barite |
| Bunmahon | Bunmahon | 1 | ✓ | Cu |
| Caim | Caim | 1 | ✓ | Pb |
| Connemara | Connemara | 3 | ✓ | Pb |
| Clontibret | Monaghan | 1 | ✓ | Pb |
| Connacht Coalfield | Connacht Coalfield | 7 | ✓ | Coal |
| Crohy Head | Donegal Talc | 1 | | Talc |
| Clare Phosphate | Clare Phosphate | 2 | ✓ | Phosphate |
| Glendalough–Glendasan | Glendalough | 8 | ✓ | Pb, Zn |
| Glenmalure | Glendalough | 2 | ✓ | Pb |
| Glentogher | Donegal Pb | 1 | ✓ | Pb |
| Gortdrum | Gortdrum | 1 | ✓ | Cu, Hg |
| Hollyford | Tipperary Minor Cu | 1 | ✓ | Pb |
| Hope (Cornalough) | Monaghan | 1 | ✓ | Pb |
| Kanturk | Munster Coalfield | 6 | | Coal |
| Keeldrum | Donegal Pb | 1 | ✓ | Pb |
| Kilbricken | Clare Pb | 1 | ✓ | Pb |
| Killaloe | Killaloe Slate | 9 | | Slate |
| Leinster Coalfield | Leinster Coalfield | 7 | ✓ | Coal |
| Redhills | Redhills | 1 | | Fe |
| Ross Island | Ross Island | 1 | | Cu |
| Silvermines | Silvermines | 6 | ✓ | Cu, Zn, Pb, barite |
| Slieve Ardagh Coalfield | Slieve Ardagh Coalfield | 10 | ✓ | Coal |
| Tassan | Monaghan | 1 | ✓ | Pb |
| Tynagh | Tynagh | 4 | ✓ | Zn, Pb, Cu, barite |
| West Cork | West Cork | 15 | ✓ | Cu, barite |

Table 2.2 Summary of mines and mine districts included in the HMS-IRC project.

## 2.3 Conceptual model

### 2.3.1 Introduction

In order to address the project a careful review of the issues that may be associated with historic mine sites was undertaken. This review involved an examination of mine records in the GSI, an examination of reported incidents from historic mine sites in Ireland, a review of available literature on the topic and discussions with CDM and Geoffrey Walton Practice (GWP) (UK) (consultants employed to provide advice specifically on the task of preparing the inventory).

It was quickly realised that in order to carry out the fieldwork that a systematic method was needed and the optimum approach would be to develop a **Conceptual Model**. This would therefore guide the data collection in the field but would not be so rigid as to prevent the recording of features unique to any one site.

The HMS-IRC project addresses the requirement of the EU Directive on wastes from the extractive industries for an inventory of waste facilities and the national need for data on physical hazards at closed and/or abandoned mine sites. Both needs have been addressed on a risk basis. However, it is important to note that this is NOT a risk assessment of the sites. Rather the sites have been ranked on a risk basis so as to determine a relative ranking for future actions.

As indicated in the previous paragraph, each site is assessed for waste facilities and for physical hazards. The former assessment looks primarily at hazards from a chemical or geochemical point of view while the latter assesses the geotechnical and site safety aspects of a site.

This section will briefly provide an overview of the conceptual model developed for contaminant risks. The scoring system for the conceptual model is described in the appendices to this report.

### 2.3.2 Contaminant conceptual model

Contaminant risks emanate from waste facilities on the site. In order to identify and assess these, the Source–Pathway–Receptor Paradigm has been used. The paradigm requires that each of the parameters within the model are documented, estimated, measured or recorded. The conceptual model to describe this is illustrated pictorially in Figure 2.1. The model identifies the source of any contamination, who or what is affected (the receptor), and how the source may reach the receptor (pathway). The conceptual model identifies all the sources, pathways and receptors. The collection of field data, observations and estimates confirms whether a linkage exists between the source and receptor and conclusions are drawn about the potential risks caused by the source of contamination. Conceptual models are used to inform and drive site investigations. Later a conceptual model may assist with the identification of remedial strategies.

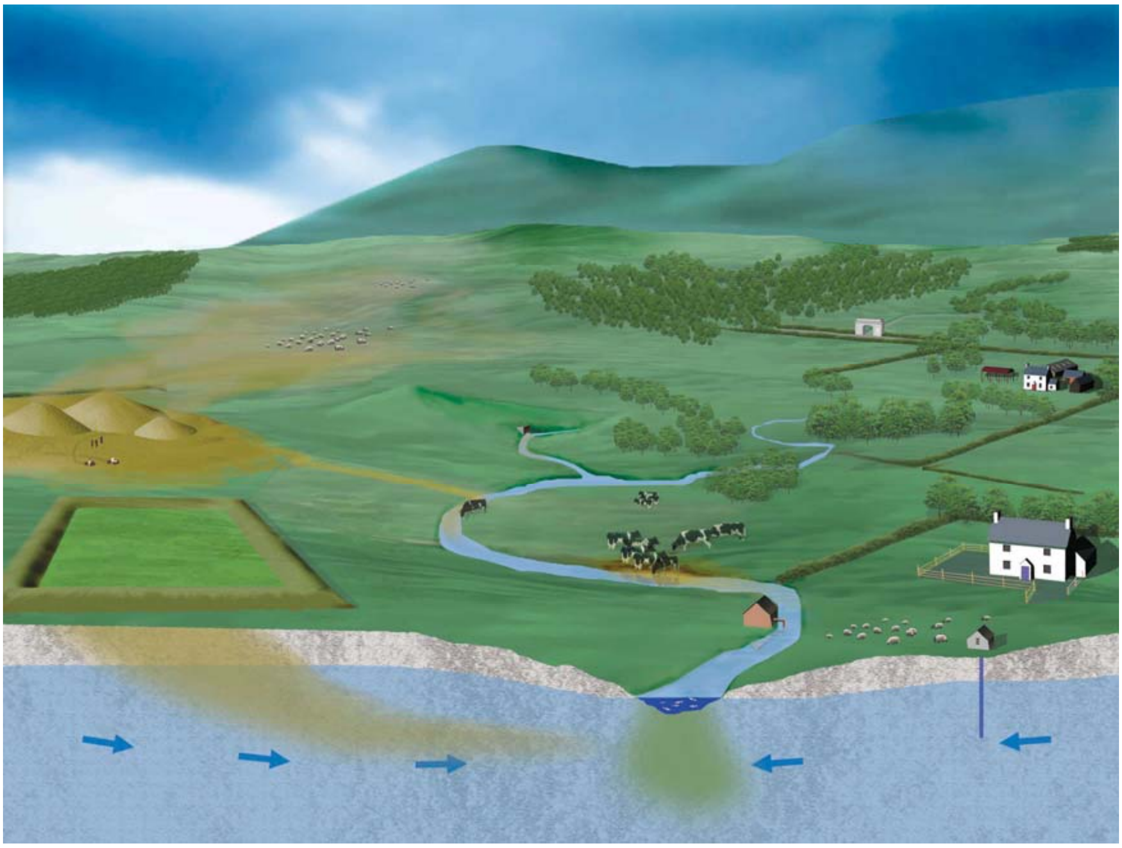

**Figure 2.1 Conceptual model for a potential historic mine contaminating the environment.**

### 2.3.3 Sources of contaminants

Sources are the origin of contaminants that may issue from a historic mine site. The cause or source of the contamination is identified as well as its location. The possible sources of contamination are listed below and illustrated in Figure 2.2:

- Liquid (water)
  - Adit discharges
  - Seeps
- Solids
  - Waste piles
  - Tailings impoundments
  - Stream sediments

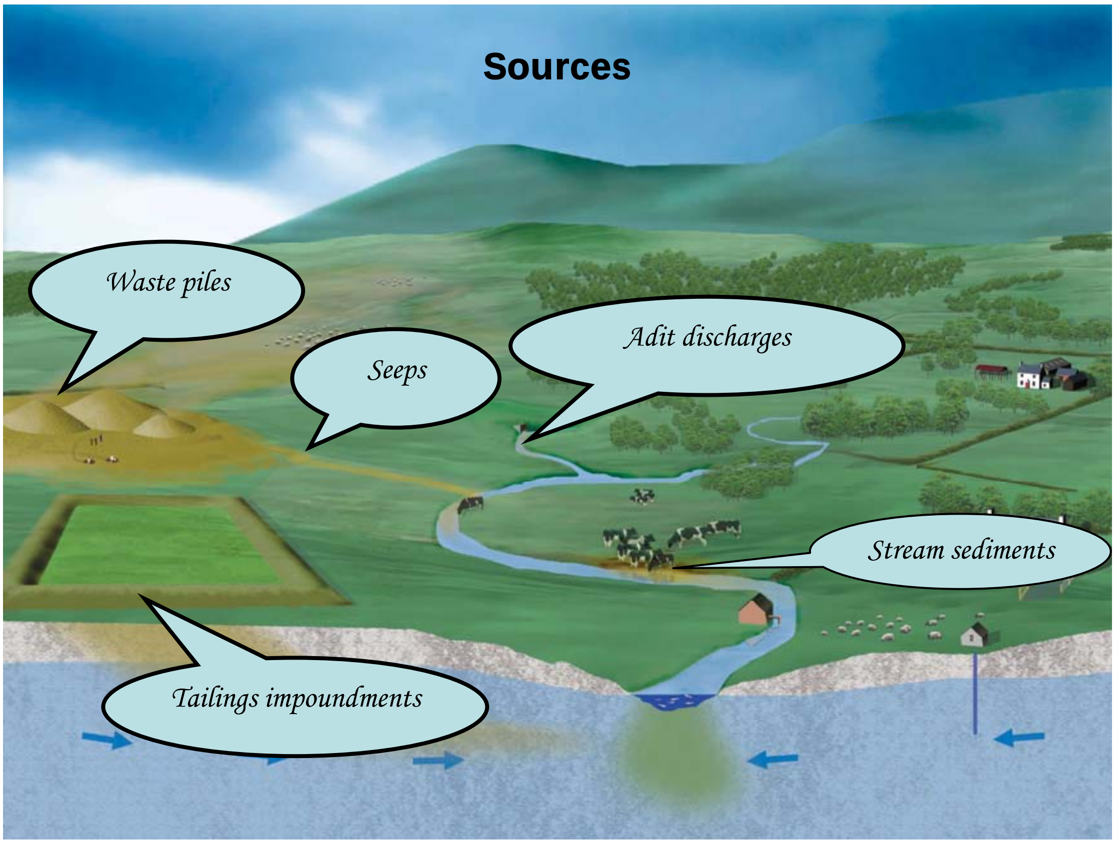


**Figure 2.2 Possible sources of contamination at historic mine sites.**

### 2.3.4 Pathways

The pathway is the route the source takes to reach the receptor. Evidence for the movement of the potential contaminants is noted for each pathway at the site. Pathways that are considered for the movement of contaminants at historic mine sites are (numbers refer to elements shown in Figure 2.3):

Groundwater

Surface water

Air

Direct contact – solid waste piles

Direct contact – stream sediments

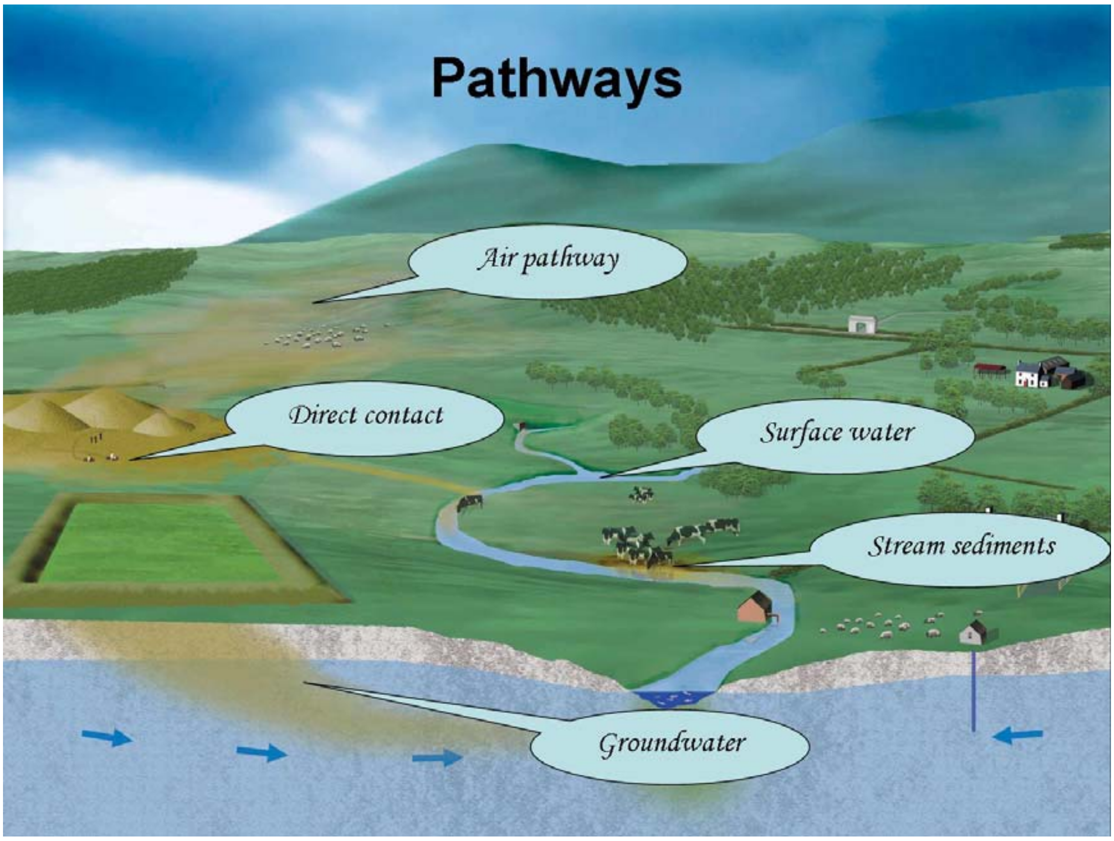

**Figure 2.3 Pathways by which potential contaminants may reach receptors.**

### 2.3.5 Receptors

Receptors are those elements of the paradigm that are affected by the potential contamination emanating from the various sources via the different pathways. If contamination is to cause harm, it must reach a receptor. A receptor is any person, animal, plant, ecosystem, protected site, or property. Receptors, in the context of the HMS-IRC project include the following, which are illustrated in Figure 2.4:

- People
  - Local inhabitants
  - Workers
  - Visitors to the site (legal or otherwise)
- Farm animals
  - Livestock
- Ecosystem/Aquatic
  - Rivers
  - Estuaries
  - Groundwater
- Protected areas
  - National Parks
  - National Heritage Areas (NHAs)

Special Protection Areas (SPAs)

Special Areas of Conservation (SACs)

Nature Reserves

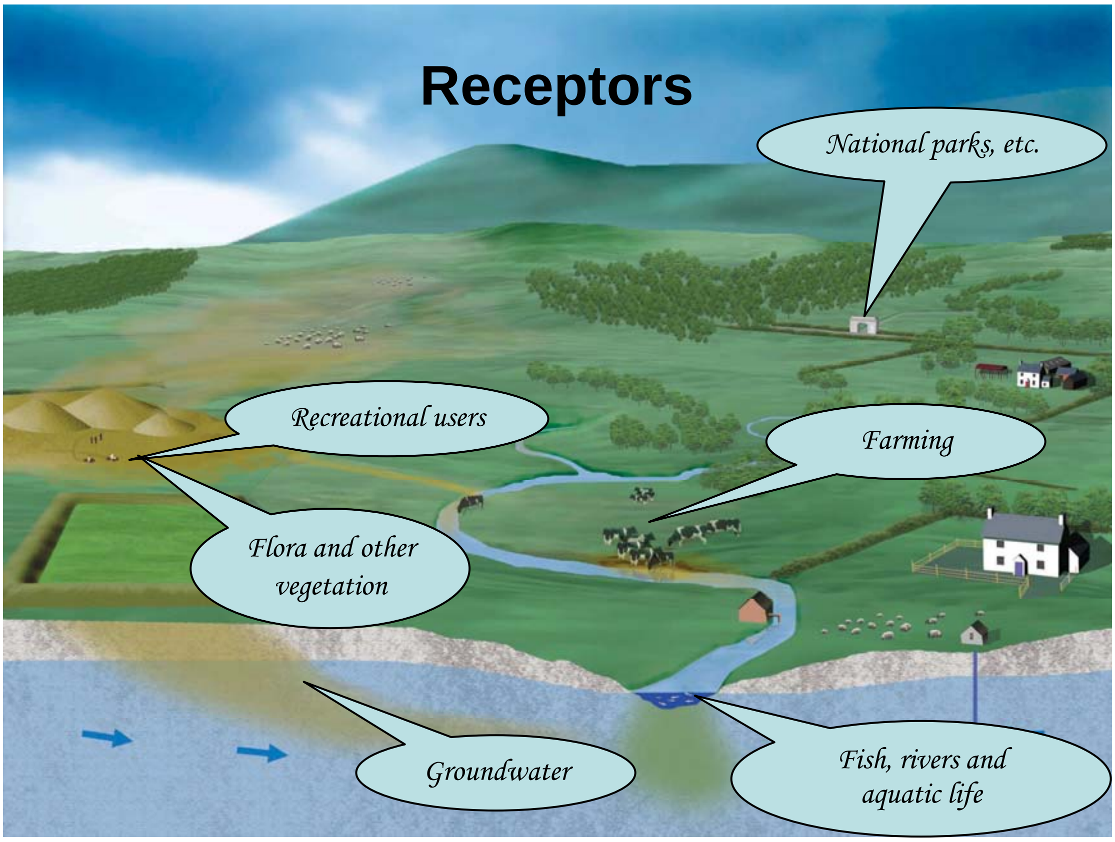


**Figure 2.4 Possible receptors that may be exposed to contamination originating from historic mine sites.**

## 2.4 Overview of scoring system

### 2.4.1 Overall philosophy

The scoring system for the historic mine sites was developed from the Abandoned and Inactive Mines Scoring System (AIMSS), which itself was devised to produce a ranking of abandoned mine sites in the State of Montana (USA) and is itself a development of the US EPA Hazard Ranking System. This is a summary of the system developed by the Project Team to score the Irish historic mine sites with assistance from international consultants CDM (USA) and Land Quality Management (LQM) Limited (UK) to take account of particular issues specific to Ireland.

The overall approach to the scoring is illustrated in Figure 2.5. The system comprises five steps. This section of the report provides a summary of Steps 4 and 5 of this process.

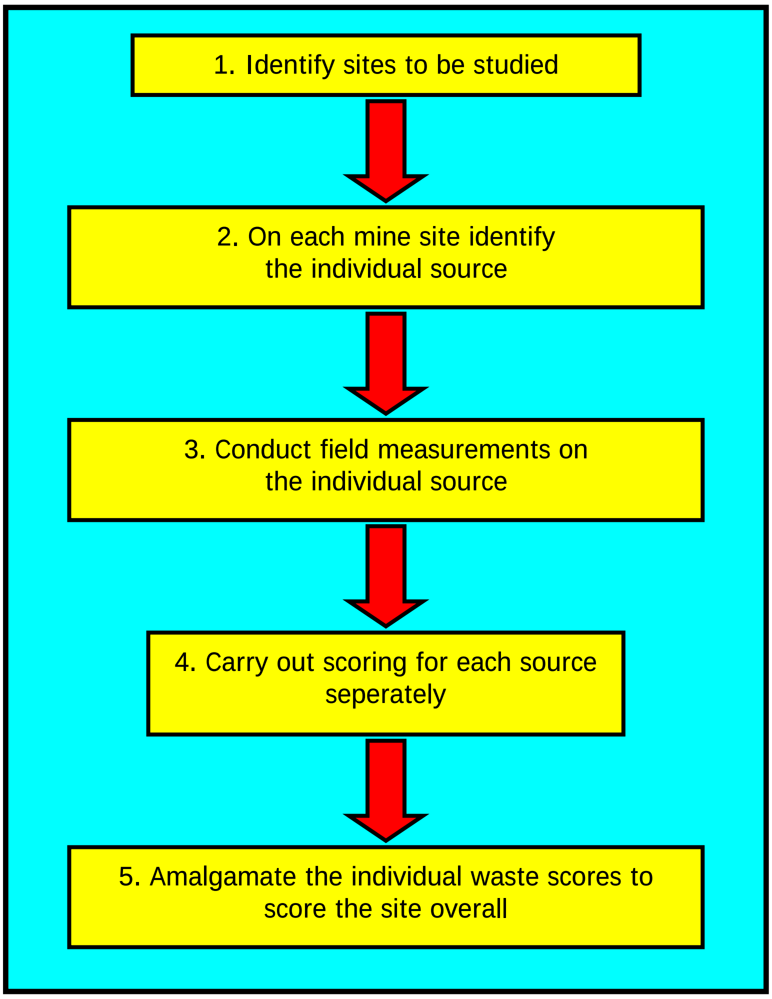


**Figure 2.5 The five steps to scoring a historic mine site for contamination hazards.**

As indicated above, each waste pile or discharge is assessed and scored separately. Five pathways are evaluated:

Groundwater pathway

Surface water pathway

Air pathway

Direct contact pathway (waste piles)

Direct contact pathway (stream sediments)

Each pathway may have a greater or lesser influence on the overall score depending upon the individual circumstances at each site.

The overall approach to scoring for each pathway is to assess and score the following three factors: hazard; likelihood of release; and receptors.

The **Hazard** of a waste pile or discharge is determined by:

The chemical composition of the waste pile or discharge;

The relative toxicities of the different constituent elements; and

The volume (or area) of the waste pile or discharge.

The **Likelihood of release** of a contaminant from a waste pile or discharge is an assessment of whether there have been releases of contaminants to the environment in the past and it addresses whether the waste pile or discharge is in any way contained. The former determines whether there have been releases of the contaminants from the mine site in the past while the latter addresses the possibility of releases from the source in the future. In all cases any contaminant must be attributable to the mine site.

The **Receptors** are the people, animals, ecosystems or protected areas that may be affected by a release from the mine site.

Each waste pile or discharge is mapped, measurements taken and other data collected on each mine site. The individual waste facilities are characterised so that the **Hazard** associated with each is known. The factors for **Likelihood of release** and the **Receptors** are recorded for each pathway at every waste pile or discharge.

The scoring process is automated with the use of an Excel workbook. There are eight worksheets in the workbook:

1. Waste hazard
2. Groundwater
3. Surface water
4. Air pathway
5. Direct contact (waste piles)
6. Direct contact (stream sediments)
7. Score
8. Lookup tables

The first worksheet scores individual waste sources that have been identified, measured, sampled and examined during this study. The next five worksheets (numbers 2 to 6 inclusive) score the named pathway. The seventh worksheet gives the overall score for the particular waste pile. The final worksheet contains the lookup tables servicing the input to the other tables. The remainder of this section outlines the criteria used in scoring the different factors for each pathway.

### 2.4.2 Hazard scoring

Within the scoring system there are three potential types of contamination hazard from one or other of the following:

1. Waste piles
2. Discharges
3. Stream sediments

As mentioned above the Hazard score is determined from the amount of contaminants, the relative toxicity of these contaminants and the volume (or area) within each source.

#### 2.4.2.1 Waste piles

For waste piles the following elemental data are entered:

Sb (median value in mg/kg)
As (median value in mg/kg)
Ba (median value in mg/kg)
Cd (median value in mg/kg)
Cr (median value in mg/kg)
Cu (median value in mg/kg)
Fe (median value in mg/kg)
Pb (median value in mg/kg)
Mn (median value in mg/kg)
Hg (median value in mg/kg)
Ni (median value in mg/kg)
Se (median value in mg/kg)
Ag (median value in mg/kg)
Th (median value in mg/kg)
U (median value in mg/kg)
V (median value in mg/kg)
Zn (median value in mg/kg)

For each pile there may be up to 50 separate analyses. The median value has been chosen as the measure of 'central tendency' as it eliminates, to some degree, the influence of extreme outliers in the data.

The volume of the waste pile is required for the groundwater and surface water pathways while the area of the waste pile is required for the air and direct contact (waste piles) pathways. So the following are required:

1. Volume of solid waste pile (value in $m^3$)
2. Area of solid waste pile (value in $m^2$)

Not all elements pose the same threat to humans or animals. For example, Pb and Cd are known to pose a greater threat to humans than, say, Cu or Fe. Also, there are different threats to different animal or human receptors. However, there are no universally accepted values of absolute toxicities for the different elements and how they affect different receptors. There is some, but not total, agreement on the basis of relative toxicities. Table 2.3 presents the relative toxicities used in this study for human and livestock receptors. It was generated from the US EPA relative toxicity table and updated with expert advice for additional elements and receptors from CDM, LQM and the Department of Agriculture, Fisheries and Food (DAFF), Ireland. The table essentially represents, on a relative basis, the threat of the indicated element to either humans or livestock if ingested or inhaled from either soil or sediment.

| **Soil and Sediment** | | |
|---|---|---|
| **Element** | **Human Ingestion & Inhalation** | **Livestock** |
| Sb | 10.00 | 0.10 |
| As | 10.00 | 0.10 |
| Ba | 0.01 | 0.01 |
| Cd | 10.00 | 10.00 |
| Cr | 10.00 | 0.10 |
| Cu | 0.00 | 0.10 |
| Fe | 0.001 | 0.01 |
| Pb | 10.00 | 1.00 |
| Mn | 0.10 | 0.001 |
| Hg | 10.00 | 1.00 |
| Ni | 10.00 | 0.10 |
| Se | 0.10 | 1.00 |
| Ag | 0.10 | 0.01 |
| Th | 10.00 | 0.01 |
| U | 10.00 | 0.01 |
| V | 0.10 | 0.10 |
| Zn | 0.01 | 0.01 |

Table 2.3 Relative toxicities for the elements indicated as used in this study if taken up from soil or sediment.

In addition to the expert input of those listed above, expert advice was also received late in the project from the Chemical Hazards and Poisons Division of the UK Health Protection Agency (UKHPA). The UKHPA agreed with 13 of the designations arrived at by our expert advisors. However, it made alternative suggestions for the following elements (Table 2.4).

| Element | CDM and LQM | UKHPA |
|---|---|---|
| Mn | 0.10 | 1.00 |
| Se | 0.01 | 1.00 |
| Tl | 0.00 | 1.00 |
| Fe | 0.001 | 0.01 |
| Cu | 0.00 | 0.01 |
| Al | 0.00 | 0.01 |
| Co | 0.00 | 0.01 |

Table 2.4 Comparison between CDM/LQM and UKHPA designations.

For thallium field-portable X-ray florescence (FP XRF) analysis is unreliable and was therefore not used in the scoring system. For Co and Se the amounts of elements were generally low and close to the detection limit (DL) and would not make any difference to the calculations. In the case of aluminium, the FP XRF does not allow for its detection (atomic number too low) and therefore Al would not contribute to the score in any case.

In order to assess the suggested changes to the relative toxicity numbers of the other elements (Cu, Fe and Mn) a number of test re-scorings were carried out. There was no material difference in the final scores.

Therefore it was decided not to use the relative toxicity numbers as suggested by the UKHPA as there was no effect on the conclusions reached in this test.

This additional expert input supported the relative toxicity numbers that had already been determined.

#### 2.4.2.2 Discharges

Chemical analysis of water was undertaken during the summer and winter months at each of the measured discharges. The value entered was the one that gave the maximum load (that is, the maximum value of flow times analysis of either the summer flow or the winter flow). For discharges the following elemental data are entered:

Al (maximum measured value, µg/l)

Sb (maximum measured value, µg/l)

As (maximum measured value, µg/l)

Ba (maximum measured value, µg/l)

Cd (maximum measured value, µg/l)

Cr (maximum measured value, µg/l)

Cu (maximum measured value, µg/l)

Fe (maximum measured value, µg/l)

Pb (maximum measured value, µg/l)

Mn (maximum measured value, µg/l)

Hg (maximum measured value, µg/l)

Ni (maximum measured value, µg/l)

Se (maximum measured value, µg/l)

U (maximum measured value, µg/l)

V (maximum measured value, µg/l)

Zn (maximum measured value, µg/l)

The volume of the discharge is measured and entered into the spreadsheet:

1. Volume of liquid waste discharge ('Observed but not measurable' OR a value in l/day).

Not all elements pose the same threat to humans, animals or different ecosystems. For example, Pb and Cd are known to pose a greater threat to humans than, say, Cu or Fe. Also, there are different threats to different animal or human receptors. However, there are no universally accepted values of absolute toxicities for different elements and how they affect different receptors. There is some, but not total, agreement on the basis of relative toxicities. Table 2.5 presents the relative toxicities used in this study for human and livestock receptors. It was generated from the US EPA relative toxicity table and updated with expert advice for additional elements and receptors from CDM, LQM and DAFF. The table essentially shows, on a relative basis, the threat of the indicated element to humans, livestock and to two different ecosystems – a freshwater aquatic system and a marine water ecosystem – if taken up from either surface or groundwater. See also discussion on input from the UKHPA on relative toxicities for humans in Section 2.4.2.1.

| Surface Water and Groundwater | | | | |
|---|---|---|---|---|
| **Element** | **Human Ingestion** | **Eco Aquatic** | **Eco Salt – Aquatic** | **Livestock** |
| Al | 0.00 | 0.10 | 0.10 | 0.001 |
| Sb | 10.00 | 0.10 | 0.10 | 0.10 |
| As | 10.00 | 0.01 | 0.10 | 0.10 |
| Ba | 0.01 | 0.001 | 0.001 | 0.01 |
| Cd | 10.00 | 10.00 | 1.00 | 10.00 |
| Cr | 10.00 | 0.10 | 0.10 | 0.10 |
| Cu | 0.00 | 1.00 | 1.00 | 0.10 |
| Fe | 0.001 | 0.01 | 0.01 | 0.01 |
| Pb | 10.00 | 1.00 | 1.00 | 1.00 |
| Mn | 0.10 | 0.00 | 0.00 | 0.001 |
| Hg | 10.00 | 10.00 | 10.00 | 1.00 |
| Ni | 10.00 | 0.10 | 1.00 | 0.10 |
| Se | 0.10 | 1.00 | 0.10 | 1.00 |
| U | 10.00 | 0.01 | 0.01 | 0.01 |
| V | 0.10 | 0.00 | 0.00 | 0.10 |
| Zn | 0.01 | 0.01 | 0.10 | 0.01 |

Table 2.5 Relative toxicities for the elements indicated as used in this study if taken up from surface or groundwater.

#### 2.4.2.3 Stream sediments

For stream sediments the following elemental data are entered:

Sb (maximum value in mg/kg)

As (maximum value in mg/kg)

Ba (maximum value in mg/kg)

Cd (maximum value in mg/kg)

Cr (maximum value in mg/kg)

Cu (maximum value in mg/kg)

Fe (maximum value in mg/kg)

Pb (maximum value in mg/kg)

Mn (maximum value in mg/kg)

Hg (maximum value in mg/kg)

Ni (maximum value in mg/kg)

Se (maximum value in mg/kg)

Ag (maximum value in mg/kg)

Th (maximum value in mg/kg)

U (maximum value in mg/kg)

V (maximum value in mg/kg)

Zn (maximum value in mg/kg)

The length of stream or river contaminated is recorded and entered into the spreadsheet. 'Contaminated' is defined as values of mine-related elements greater than three times the upstream value for that element.

#### 2.4.2.4 Contaminated stream sediments (value in metres)

As in the other hazard sources not all elements pose the same threat to livestock in stream sediments. However, there are no universally accepted values of absolute toxicities for different elements and how they affect livestock if ingested from stream sediments. There is some, but not total, agreement on the basis of relative toxicities. Table 2.6 shows the relative toxicities used in this study for human and livestock receptors. It was generated from the US EPA relative toxicity table and updated with expert advice for additional elements and receptors from CDM, LQM and DAFF. The table essentially represents, on a relative basis, the threat of the indicated element to livestock if taken up from stream sediments.

| **Soil and Sediment** | |
|---|---|
| **Element** | **Livestock** |
| Sb | 0.10 |
| As | 0.10 |
| Ba | 0.01 |
| Cd | 10.00 |
| Cr | 0.10 |
| Cu | 0.10 |
| Fe | 0.01 |
| Pb | 1.00 |
| Mn | 0.001 |
| Hg | 1.00 |
| Ni | 0.10 |
| Se | 1.00 |
| Ag | 0.01 |
| Th | 0.01 |
| U | 0.01 |
| V | 0.10 |
| Zn | 0.01 |

Table 2.6 Relative toxicities for the elements indicated as used in this study if taken up from stream sediments by livestock.

Having entered all relevant data, a **Hazard** score is generated for each pathway within the spreadsheet and used in the overall calculation of the score for that pathway (for further detail see Appendix 1).

### 2.4.3 Likelihood of release score

The following inputs were used for each of the pathways.

#### 2.4.3.1 Groundwater pathway

| Criterion | Options |
|---|---|
| Observed release | YES or NO |
| Exceedances of water standards | YES or NO |
| Potential to release | |
| Containment at site (select from list) | 1. No containment<br>2. Presence of ONE of the following: berm, liner, run-on diversions or vegetated cover<br>3. Presence of TWO of the following: berm, liner, run-on diversions or vegetated cover<br>4. Presence of THREE of the following: berm, liner, run-on diversions or vegetated cover<br>5. Completely contained – presence of ALL FOUR of the following: berm, liner, run-on diversions or vegetated cover |
| Depth to water table | Enter value in metres |

#### 2.4.3.2 Surface water pathway

| Criterion | Options |
|---|---|
| Observed release | YES or NO |
| Exceedances of water standards | YES or NO |
| Potential to release | |
| Containment at site (select from list) | 1. No containment<br>2. Presence of ONE of the following: dams, diversions, pit lakes and sediment basins or traps<br>3. Presence of TWO of the following: dams, diversions, pit lakes and sediment basins or traps<br>4. Presence of all THREE of the following: dams, diversions, pit lakes and sediment basins or traps |
| Distance from waste pile or discharge to nearest surface water drainage (select from list) | 1. <10 m<br>2. 10–30 m<br>3. >30 m |

#### 2.4.3.3 Air pathway

| Criterion | Options |
|---|---|
| Observed release (select from list) | 1. Yes (dust blow observed, evidence of waste blown from a pile, reliable eyewitness accounts)<br>2. No |
| Potential to release – containment at the site (select from list) | 1. High dust potential (<50% cover or screening)<br>2. Moderate dust potential (50–75% cover or screening)<br>3. Low dust potential (75–95% cover or screening)<br>4. No dust potential (>95% cover or screening) |

#### 2.4.3.4 Direct contact pathway (waste piles)

| Criterion | Options |
|---|---|
| Observed exposure | |
| Residence within 250 m of the waste pile | YES or NO |
| Recreational activities taking place at the site (direct observation or evidence) | YES or NO |
| Potential to release | |
| Site accessibility (select from list) | 1. Easily accessible (no fences, gates or signs)<br>2. Moderately accessible (barbed wire fences, road gated, signage)<br>3. Difficult access (chain link fence, road gated and locked)<br>4. Not accessible (site completely fenced, access road gated and locked, on-site security within 250 m of the waste piles) |
| Condition of restrictions (select from list) | 1. Well maintained, no breaches<br>2. Small animals can access with ease, humans and animals can access with difficulty. Vehicles cannot gain entry. Less than three breaches.<br>3. Small animals, human and livestock can access with ease. Vehicles can enter. Less than five breaches.<br>4. Small animals, human and livestock can access with ease. Vehicles can enter or more than five breaches |
| Distance to nearest residence | Enter value in metres |

#### 2.4.3.5 Direct contact pathway (stream sediments)

| Criterion | Options |
|---|---|
| Observed exposure | |
| Farm within 250 m of the waste pile | YES or NO |

Having entered all relevant data, a **Likelihood of release** score is generated within the spreadsheet and used in the overall calculation of the score for that pathway.

### 2.4.4 Receptor score

The following is input for each of the pathways.

#### 2.4.4.1 Groundwater pathway

| Criterion | Options* |
|---|---|
| Aquifer category (select from list). The aquifer classification has been developed by the GSI/EPA and the GSI has maps for the country indicating the type of aquifer. This information was used for the groundwater pathway. | 1. Rk – Karstified<br>2. Rkc – Karstified, dominated by conduit flow<br>3. Rg – Extensive sand/gravel<br>4. Rkd – Karstified, dominated by diffuse flow<br>5. Rf – Fissured bedrock<br>6. Lm – Generally moderately productive<br>7. Ll – Moderately productive only in local zones<br>8. Lk – Locally important karstified aquifer<br>9. Lg – Local sand/gravel<br>10. Pl – Generally unproductive except for local zones<br>11. Pu – Generally unproductive |
| Number of wells within 1 km | Number of wells from CSO statistics adjusted for area from a GIS. |
| Vulnerability of groundwater adjustment (select from list as determined from groundwater vulnerability map (GSI)) | 1. Extreme (rock near surface or karst)<br>2. Extreme<br>3. High<br>4. High to low<br>5. Moderate<br>6. Low<br>7. No data |

*Note R = Regional and L = Local.

#### 2.4.4.2 Surface water pathway

| Criterion | Options |
|---|---|
| Total number of persons using surface water for drinking from all abstractions within a 10-km radius | Enter number from CSO statistics |
| Is there a local stream/drainage within 100 m? | YES or NO |
| Other users | |
| Fishery class (select from list) | 1. Salmonid<br>2. No classification |
| Recreational use (select from list) | 1. Observed (fishing or boating or |

| | |
|---|---|
| | swimming, etc.)<br>2. Not observed |
| Protected area status (select from list) | 1. Yes (National Park, SAC, SPA, NHA)<br>2. No designation |
| Livestock watering (select from list) | 1. Yes<br>2. Unknown |

#### 2.4.4.3 Air pathway

| Criterion | Options |
|---|---|
| Population within 1 km of the waste | Enter value from CSO statistics |
| Distance to the nearest residence | Enter value in metres |
| Protected areas (NHAs, SPAs, SACs, Nature Reserves or National Parks) | YES or NO |

#### 2.4.4.4 Direct contact pathway (waste piles)

| Criterion | Options |
|---|---|
| Population within 2 km of the site | Enter number from CSO statistics |
| Distance to the nearest residence | Enter value in metres |
| On-site workers (select from list) | 1. Predominantly working outside<br>2. Farmers<br>3. Predominantly working inside<br>4. No workers |
| Attractiveness of the site for recreational use (select from list) | 1. Highly attractive<br>2. Moderately attractive<br>3. Low attractiveness<br>4. Not attractive |

#### 2.4.4.5 Direct contact pathway (stream sediments)

| Criterion | Options |
|---|---|
| Livestock accessing the stream (select from list) | 1. Livestock observed in stream or other signs, e.g. hoof marks<br>2. Unknown |

Having entered all relevant data a **Receptor** score is generated within the spreadsheet and used in the overall calculation of the score for that pathway.

### 2.4.5 Total site score for human and animal health

The total score has been set up in the spreadsheet to be automatically generated for an individual waste pile or discharge or stream sediment section by first multiplying the **Hazard** score by the **Likelihood to release** score by the **Receptor** score and then summing the relevant pathways. For a waste pile or discharge source, the groundwater, surface water, air and direct contact pathways are summed. For the stream sediment source just the stream sediment pathway is used.

### 2.4.6 Total mine site score

For an individual mine site all the individual scores for waste piles, discharges and stream sediments are summed. This is the final score for the site.

**2.5 Classification** Once the final score for the mine site is obtained it is assigned to one of the following classes:

| Class | Score | Description | Response |
|---|---|---|---|
| I | >2,000 | Relates to large complex sites that have a number of issues, the sites contain large volumes of metal-rich waste that potentially pose risks to human and animal health and safety as well as to the environment. | These sites should have a full risk assessment carried out. These sites should be monitored on an ongoing basis. |
| II | 1,000 – 2,000 | A district consisting of several sites, containing numerous small spoil piles with high concentrations of metals and are visited regularly by the public. Accordingly these sites potentially pose risks to human and animal health and safety as well as to the environment. | These sites require general monitoring of most or all waste piles, discharges or stream sediments on an annual basis. |
| III | 300 – 1,000 | Sites containing fewer and smaller spoil piles that have high concentrations of metals. The sites are used by the public and potentially pose risks to human and animal health and safety as well as to the environment. | These sites require general monitoring of most or all waste piles, discharges or stream sediments on a biennial basis. |
| IV | 100 – 300 | Sites that generally have large volumes of waste with low concentrations of those metals that potentially pose risks to human and animal health and safety as well as to the environment. Any high metal spoil piles are very small in volume. | These sites require specific monitoring of particular waste piles, discharges or stream sediments on a five-yearly basis. |
| V | <100 | These sites pose little threat to humans, animals or the environment, although there may be minor site-specific issues which need to be addressed | These sites generally do not require monitoring except where there are minor specific issues. |