Ref: CHECKED

Please see Annex AC9 for supporting information, and the “Introduction” for Health and Safety considerations and advice on the use of the guidance.

1. **Is underdrainage proposed**
   Most restored mineral sites will require underdrainage where agriculture is the after-use. Even on sites where the soil pre-working was free draining, drainage is usually impaired following restoration. Prior to underdrainage, have additional measures been proposed to mitigate against drainage and erosion problems?

2. **Have the drainage proposals been submitted in accordance with the planning conditions**

3. **Check drainage proposals for the following details**
   a. **timing of underdrainage**
   b. **soil type**
   c. **drain spacing, design and layout, drain size, depth, and gradient**
   d. **adequate outfalls**
   e. **permeable backfill proposed**
   f. **secondary treatments proposed (e.g. subsoiling and mole drainage)**
   g. **what surface drainage is proposed (e.g. ditches)**
   h. **ensure drainage proposals do not adversely affect adjoining land**

4. **Following underdrainage, monitor the following at aftercare/site meetings**
   a. **are the drain outfalls clear and unobstructed**
   b. **are ditches of adequate capacity**
   c. **is the ditch clear, unobstructed and properly graded**
   d. **is there surface evidence of poor drainage. If yes, investigate further**
   e. **is the site in appropriate condition for normal agricultural operations to proceed**
   f. **has a final plan (to scale) been submitted**
   g. **check the potential for erosion**
   h. **check for problems caused off site (e.g. water run-off, inadequate surface water drainage)**
For more detailed information see:
- Workmanship and Materials for Land Drainage Schemes (ADAS 1995)
- The Reclamation of Mineral Workings to Agriculture (DoE 1996)
  Guidance on Good Practice for the Reclamation of Mineral Workings to Agriculture (DoE 1996)
- The Design of Field Drainage Systems (MAFF Booklet 345)

Cross references:
- AP 5, 6
- RN 3, 8, 10
- AC 3, 6
1. Is underdrainage proposed

The purpose of underdrainage (also referred to as field drainage) is to remove excess soil water in order to provide a suitable soil environment and soil surface conditions for cultivation, harvesting and/or grazing by livestock. The need for underdrainage should not be confused with proposals to deal with surface water run-off.

In agricultural terms the soil needs to maintain:
- chemical fertility
- favourable physical conditions

Both of these factors are dependent on the soil retaining an adequate, but not excessive, amount of water within the rooting depth of the crops to be grown. Throughout the farming year the soil must be:
- capable of supporting heavy machinery or stock without being damaged
- ‘workable’ to allow the preparation of a seed bed
- ‘open’ enough to permit root development, good drainage and aeration

Restored soil has lost its natural structure and cracking which facilitates natural drainage and root development. It can often be compacted, making favourable conditions for cropping much more difficult to achieve. Poorly drained land reduces the cropping flexibility, workability and general efficiency of the soil. This in turn has a direct influence on land quality, a significant factor to be taken into account on many sites.

2. Have the drainage proposals been submitted in accordance with the planning conditions

Proposed final levels of the restored site should assume that underdrainage will be required. This should ensure, if considered necessary, that the whole of the site can be underdrained. Final restoration proposals should identify and make available adequate outfall facilities for the underdrainage scheme, viz. new ditches, soakaways, existing drains etc. Without a satisfactory outfall, an effective drainage system cannot be installed.

It is important that detailed drainage proposals are submitted allowing the maximum period of notice in order to allow consultation and discussion to take place. This will permit amendments to be made to the proposed scheme as necessary. The drainage plan needs to be to scale, show sufficient levels to demonstrate the effectiveness of the design, and identify the different pipe sizes to be used, normally through colour coding. Outfalls and the use of a permeable backfill (sometimes referred to as porous fill) will also need to be shown where appropriate.
3. Check drainage proposals for the following details

a. timing of underdrainage
   The need for underdrainage may arise at anytime following completion of restoration. There is some debate on whether drainage should be installed at the beginning of aftercare, and risk the potential effects of settlement, or left for a few years until the worst of the settlement has been achieved. Each case needs to be considered on its merits. A sacrificial type scheme may be necessary if the situation is so severe that other agricultural aftercare obligations cannot properly be met. Drainage schemes are often installed after harvest, when ground conditions are conducive to being trafficked by heavy machinery. In this respect, the timing of the operation is crucial, as significant soil structural damage can occur if work is carried out during poor weather and/or ground conditions.

b. soil type
   On undisturbed land, drainage is usually only carried out on those soils with a significant clay content, i.e. the texture of the soil is such that water cannot percolate through the profile quickly enough to prevent growing plants from experiencing stress. However, where soil has been disturbed, drainage problems can occur over most soil types, including those which in their normal undisturbed state would be classed as free draining, due to the loss of the natural soil structure and possible effects of compaction.

c. drain spacing, design and layout, drain size, depth and gradient
   A typical scheme may be made up of lateral drains (continuous lengths of perforated plastic pipe - of 8, 10 and 15cms diameter) laid across the main slope of the site to be drained, either outfalling directly into a ditch, or connected to a main drain laid along the headland (or through a valley feature), which will carry the water to the nearest ditch or outfall point. The lateral drains will normally be laid to a minimum depth of 60cms and covered with permeable backfill (usually washed gravel - size 0.5-5cms) laid to within 22cms of the ground surface. An average spacing between the lateral drains would be in the region of 20-40 metres, depending on soil type, gradient, topography etc. A secondary treatment, such as mole drainage and/or subsoiling will then be carried out at right angles to the drains (down the main slope) with the foot of the subsoiler/mole drain passing through the gravel layer above the drains. The actual depth of this secondary treatment is a crucial aspect of the drainage scheme and will need to be determined by an examination of the restored soil profile. Again, this will be part of the whole drainage design as described earlier. Underdrainage schemes should be designed by a competent and experienced person. All schemes should take into account the guidance given in The Design of Field Drainage Systems (MAFF Booklet 345). A poor scheme design and layout may actually make the situation worse. Land Drainage contractors will normally design their own schemes, and the Land Drainage Contractors Association (LDCA) based at the National Agricultural Centre, Stoneleigh, Warks. can provide details of their members for any given area.
d. adequate outfalls
Underdrainage outfalls, particularly where laid into a newly cut ditch, should be fitted with a headwall and splash plate to avoid the risk of eroding the newly cut ditch banks, especially where dug into restored soil and before vegetation has had the chance to become established. Coloured stakes or some other form of marker should be placed at the top of the ditch bank, to identify the outfall points for future ditch maintenance works etc.

e. permeable backfill proposed
Permeable backfill is a material which allows rapid water movement through it to the drains. The most commonly used materials are washed gravel, (sometimes available from the site itself), crushed stone, granite chippings etc. The material should be clean, free of fines and not contaminated with soil. The cost of using permeable backfill can amount to half the cost of the whole drainage scheme and is sometimes omitted from the design for this very reason. The reasons for its use need to be carefully considered and clearly understood. Its main function is to assist the passage of water by making a positive connection to the drain following mole drainage or subsoiling. These secondary treatments create channels and/or fissures to improve water movement within the soil profile.

f. secondary treatments proposed (e.g. subsoiling and mole drainage)
Subsoiling and mole drainage are known as secondary treatments, and are carried out after the drainage system has been installed when soil conditions are favourable. The aim of mole drainage is to create an underground channel which will collect water and feed it to the permeable backfill above the drains. A stable soil structure with a high clay content is normally required for this to be successful, and it is therefore unlikely to be carried out on restored soil, particularly where imported soil of different textures have been used. Subsoiling is the more common treatment on restored land and is carried out mainly to relieve the effects of soil compaction, creating a heave in the restored profile, again allowing water down through the profile and into the permeable backfill. The depth and spacing of each of these operations can only be determined by an examination of the restored profile. To carry out the work as a routine operation is costly and can, in some circumstances, make a drainage problem worse.

g. what surface drainage is proposed (e.g. ditches)
New ditches should be dug to such a depth as to provide a sufficient outfall for the drainage system (see earlier comments re. drain depth). The ditch banks should be graded so that they do not easily slip into the ditch bottom. Newly cut ditches are particularly prone to slippage/erosion, especially where dug in restored soil. In such circumstances, consideration should be given to seeding the banks to create a mat of vegetation, which will help stabilise the ditch sides. Depending on the after-use of the site, there may be an opportunity to seed the banks with a conservation type mix, which may establish well in a low nutrient environment.
h. ensure drainage proposals do not adversely affect adjoining land

The restored site can have an impact on adjoining land in two ways. Firstly, the newly created contours of the restored area may require the creation of a new outfall, which may impact on the adjacent land. This should have been taken into account when the restoration proposals were being prepared. If not, then discussions may be necessary with the landowner in order to arrange for an outfall across his/her land. Secondly, if the restored site lies downslope of adjacent land and provided an outfall for that land prior to the development, then discussions will need to take place to establish continuity of flows.

4. Following underdrainage, monitor the following at aftercare/site meetings

a. are the drain outfalls clear and unobstructed

Ditch bank slippage, vermin, vandalism, vegetation etc. can all cause significant damage to the drain outfalls, which need to be kept clear at all times. A blockage of the outfall could cause severe problems in the field causing waterlogging/surface ponding etc., leading to crop damage and if left uncorrected, crop losses.

b. are ditches of adequate capacity

If the main function of the ditch is simply to act as the outfall for the drainage of the site, it need normally be no greater in dimension than necessary to allow the drains to outfall a few centimetres above the ditch bed, with side slopes graded to prevent slippage. However, it may be that the ditch has an additional function, i.e. carrying water from outside the site, in which case the design may be more crucial and professional advice should be sought. The drainage designer should take this into account as part of the design of the scheme.

c. is the ditch clear, unobstructed and properly graded

Regular maintenance of the ditch is essential if the field drainage system is to operate effectively. Such maintenance will involve regular inspections to remove general rubbish etc., repair of bank slips, re-alignment of the outfall pipes themselves if they have dropped, and mowing/flailing of the vegetation to keep the channel clear. With regard to mechanical operations, it is important to have the high visibility outfall stakes (as referred to earlier) in place, so that the outfall pipes themselves are not broken/damaged. Depending on the location of the site, its after-use and the vegetation on the ditch bank, the timing of maintenance operations may be crucial from a wildlife/conservation interest and this factor should be taken into account when arranging this type of operation.

d. is there surface evidence of poor drainage. If yes, investigate further

There may be many reasons why there is surface evidence of poor drainage following the installation of a drainage system. A methodical approach is more likely to lead to the most obvious causes. First of all, check the site records to ensure that all the work planned has indeed been carried out, and if it has, was it completed in good conditions and were there any problems. Check the drain
outfalls and the condition of the outfall ditch/pipe/soakaway etc. for damage/blockages etc. Has differential settlement caused some drains to flow backwards; a level survey may be required to prove this. Examination of the soil may indicate severe compaction or a different soil type in this particular area, requiring additional remedial works.

e. **is the site in appropriate condition for normal agricultural operations to proceed**
   There may be obvious reasons why this may not be the case, i.e. restoration not yet be complete, site too uneven, materials/equipment left on site, poor access to the area etc. Reasons such as these can easily be documented and the remedial work put in hand. It is also important to have the farmer/landowner or contractor who will be carrying out the agricultural cultivations on site. They are probably in the best position to make more detailed and relevant comments on whether the land can be returned to normal agricultural operations. Their opinions and co-operation in these cases can be crucial.

f. **has a final plan (to scale) been submitted**
   It is essential for future reference that a final plan is produced of where the drains have been laid. This needs to be to scale, normally 1:2500, with clear measurements and tie-lines. Thus, in years to come, when all surface evidence of the drainage work has disappeared, if a drainage problem is suspected, the final plan can be used to determine whether a drain is at fault and if so, where to locate it. Copies should be provided to the MPA, the landowner and one should be held with the site operators aftercare record.

g. **check the potential for erosion**
   The risk of erosion is at its worst when the ground is bare and sloping, a condition common to restored sites. It is important, therefore, to establish vegetation as quickly as possible, both on the restored areas and the ditch banks. If the time of year prevents normal agricultural cropping, a green manure crop, e.g. mustard, may provide the necessary cover until such time as the seasonal cultivations can take place. The installation of drainage headwalls and splash plates in the ditch bank will significantly reduce the risk of ditch bank erosion.

h. **check for problems caused off site (e.g. water run-off, inadequate surface water drainage)**
   Allied to the previous point, run-off/erosion is not confined to within the boundaries of the site. Severe damage can be caused to neighbouring land and property if water from within the site is not managed properly. Adequate drainage, ditches and managed vegetation will all help reduce the level of risk associated with restored sites.