



DARTMOOR TRAINING AREA

Environmental Appraisal

# Soils, Geology and Groundwater

# 13

## 13. Soils, Geology and Groundwater

### 13.1 Introduction

13.1.1 Potential effects from military training in relation to soils, geology and groundwater include pollutants from vehicles used to move troops, to access Okehampton and Willsworthy Camps, and from sources within the camps themselves. This chapter was completed by Rachel Dimmick (B.Sc., M.Sc., AIEMA) and replicates information from a Land Quality Assessment completed by Entec.

### 13.2 Context

#### Legislative Context

13.2.1 The regulatory regime for defining, identifying and remediation of contaminated land is Part IIA of the Environmental Protection Act (EPA) 1990. It is supported by the Contaminated Land Regulations and Statutory Guidance and provides a new regime for the identification and remediation of contaminated land.

#### Policy Context

13.2.2 **Table 13.1** provides information on the policy context relating to soils, geology and groundwater.

**Table 13.1 Policy Context: Soils, Geology and Groundwater**

Policy Reference	Policy Content and Guidance
DNPLP Policy GP2	Planning permission will be granted where development will not lead to pollution of air, water or soils.
SWRSS Policy RE7	Local authorities, other agencies and the private sector will promote an integrated approach to land management by developing area-specific packages which achieve multiple benefits, reinforce and enhance the specific natural and cultural features of local areas.
PPS23-2 Policy 2.5	Contaminated land is any land which appears to the local authority to be in such a condition, by reason of substances in, on, or under the land that significant harm is being caused or there is a significant possibility of such harm being caused; or pollution of controlled waters is being, or is likely to be caused
PPS23-2 Policy 2.18	A potential developer will need to satisfy the local authority that unacceptable risk from contamination will be successfully addressed through remediation without undue environmental impact during and following the development.
PPS23-2 Policy 2.17	Developer should carry out an adequate investigation to inform a risk assessment to determine whether the land in question is already affected by contamination through source – pathway– receptor pollutant linkages, whether new linkages by which existing contaminants might reach existing or proposed receptors will be greater and whether it will introduce new vulnerable receptors; and what action is needed to break those linkages and avoid new ones.
PPS23-2 Policy 2.42	Where contamination is known or suspected or the proposed use would be particularly vulnerable, sufficient information should be required to determine the existence or otherwise of contamination, its nature and the risks it may pose and whether these can be satisfactorily reduced to an acceptable level.
PPS23-2 Policy 2.44	A desk study and site reconnaissance will assist in determining the need for and scope of further investigation, the problems that may require remediation and whether remediation can be secured by means of planning conditions.

Policy Reference	Policy Content and Guidance
PPS23-2 Policy 2.44	Where the desk study and site reconnaissance does not provide sufficient information to assess the risks and appraise remedial options, further investigations will need to be carried out before the application is determined.
PPS23-2 Policy 2.44	In determining applications, the LPA will need to be satisfied that the development does not create or allow the continuation of unacceptable risk arising from the condition of the land in question or from adjoining land.

## 13.3 Scope of the Assessment

### Consultations

13.3.1 Soils, geology and groundwater effects were considered as part of the discussions which took place in the Land Use Working Group (LUWG) meetings. As a result of these discussions, no changes to the scope of the assessment were identified, however the issue of clearance of Unexploded Ordnance (UXO) was raised in these meetings. This issue is discussed further under **Section 13.5**. For further information on the LUWG meetings see **Chapter 8**.

### Effects Requiring Further Consideration

#### Effects Scoped-in in the Scoping Report

13.3.2 The context for assessment of land quality and groundwater effects has not been defined in any detail and therefore historical site use may have residual effects, which are not related to current land uses. Therefore, the following potential effects will be considered further in the EA:

- Effects from the historical and/or current storage and loss of motor fuels, aviation fuels, heating oils and other hydrocarbons;
- Effects from the historical and/or current disposal of waste including broken/surplus material and explosive ordnance remnants (as both a detonation risk and a toxicity risk);
- Effects from the historical and/or current use, storage and disposal of any other potential contaminating materials with potential for contamination of soils; and
- Effects from the historical and/or current shallow digging.

#### Effects Subsequently Scoped-in to the Appraisal

13.3.3 Stakeholders raised the issue of clearing UXO from the moor in the LUWG meetings. Although this issue has not been appraised in detail further discussion is provided under **Section 13.5**.

### Effects Not Requiring Further Consideration

#### Effects Scoped-out in the Scoping Report

13.3.4 The following potential effects will not be considered further in the EA:

- Potential effects from military activities on geological outcrops: Such effects are managed through the EMS, which includes measures to prevent damage to outcrops, and areas of educational importance. These outcrops are included (by the County

Council) on the Educational Register of Geological Sites in the county. Effects on locations that are used for adventurous training have been scoped out of the EA on the basis that standard climbing practices are used, which prevent permanent damage to the outcrops.

- Potential soil erosion effects from use of military vehicles: Vehicle use off road is limited and any ruts resulting from the use of vehicles are repaired. The majority of military training is on foot and there is no empirical evidence of significant footpath erosion being caused by military activities. Therefore, erosion effects have been scoped out of the EA.
- Groundwater and land quality contamination resulting from wind-blown dusts: Wind blown dust is not a significant source of groundwater and land quality contamination inside or outside DTA and has therefore been scoped out of the EA.

#### Effects Subsequently Scoped-out of the Appraisal

13.3.5 No additional effects have been scoped-out of the appraisal.

### 13.4 Environmental Management Measures

13.4.1 Responsibility for the implementation of the mitigation measures lies with the MoD through DTE to Commandant (Comdt) DTA assisted by Senior Land Agent (SLA) DTE SW and MoD's Service Provider. Implementation and compliance will be ensured through DTA's EMS, management plans and DTE SW Standing Orders (SOs).

13.4.2 The existing management measures which are in place to minimise potential effects in relation to soils, geology, groundwater and overall land quality are outlined as follows.

- Spillage plan to minimise risk of pollution effects from fuel spillages. Staff are trained in order to ensure that fuels are stored and dispensed correctly and risks are minimised in the event of fuel spillage.
- POL points are purpose built with impervious surface and separated from other buildings at the bottom of Okehampton Camp
- The intake lid and fuel nozzles on the POL points are locked when not in use
- The sewage farm is designed to contain spillages from POL points
- Trucks Tanker Fuel (TTF) park in the POL point
- The storage and delivery of fuels is limited to 7,000 litres per tank in order to be within the capacity of the Sewage Farm in the event of a spillage
- Fuel tank levels are checked twice each week
- Empty ammunition cases are removed from the training areas and returned as salvage
- Fuel storage, refuelling and vehicle and helicopter parking points are carefully controlled and sited appropriately. The siting of portaloos is also carefully controlled to minimise the potential for pollution. Areas used for training exercises are cleared after exercise.
- Digging is only allowed in areas specifically allocated by the Training Area Marshall (TAM) and in areas where EOD has been cleared. Where digging is permitted the ground must be reinstated afterwards

- Distribution and display of information (leaflets, newspapers, information boards, Dartmoor ranges website) to the public warning of the dangers of UXO and the actions that should be taken should UXO be found. DNPA Rangers and guided walk leaders are also briefed about UXO as are Year 6 pupils in the WDBC catchment area.
- Searches for UXO after exercises have been completed and periodic sweeps of the training area to ensure they are free of military debris

13.4.3 The Land Quality Assessment (LQA) work completed by Entec (September, 2007) has identified three options for the management and possible further investigation of any potential sources of contamination identified through the desk study work completed for the LQA.

## 13.5 Assessment of Potential Effects

### Data Gathering and Survey Work

13.5.1 Information to inform the assessment has been taken from the LQA (Entec, 2007). The LQA is based on data from general mapping sources and public body records, including the relevant topographical, geological and groundwater vulnerability maps of the area, British Geological Survey, the Landmark Information Group and aerial photographs from the Camp records office. MoD sources included the site Camp Commandant and the Landmarc Support Services. A site walkover was completed as part of the LQA work.

### Current Conditions

#### Site Description

13.5.2 Okehampton Camp comprises of over 150 military buildings and associated services. These buildings include POL points, Accommodation, Dining Halls, Sewage Treatment works and a Hospital. Some of the buildings are known to contain asbestos bound cement. There is also history of demolished buildings, which again are thought to have contained asbestos bound cement.

13.5.3 The site was originally developed in the 1870s and was used by the army; by 1893 construction of the original permanent camp began. Military training has taken place on Dartmoor since the early 1800s, artillery firing started in 1875. The area was used intensively for tactical exercises with live ammunition during the Second World War.

13.5.4 The first Willsworthy Camp was constructed prior to 1965, it was then demolished and in 1997 a new building was built at Willsworthy close to the area where the original buildings were.

#### Environmental Setting and Site Sensitivity

13.5.5 A variety of people use Dartmoor Training Area (DTA) including both military and civilian personnel. All have the potential to come into contact with site derived soils through activities such as trench digging (military only), walking, climbing, farming etc. A moderate sensitivity is therefore assessed for all human receptors.

13.5.6 The site is underlain by either granite or a variety of metamorphosed sedimentary rocks with only thin drift cover of either low or intermediate leaching potential. All of these are classed as a minor aquifer and are known to have groundwater abstractions at a number of locations across DTA. As such the aquifer is assessed as being of moderate sensitivity. A number of small streams and rivers flow from DTA. These form the catchment and source for a number of larger rivers and reservoirs, used for drinking water

off site. Several abstractions (potable and other) are also taken from these waters within DTA. These are therefore assessed as being of high sensitivity.

- 13.5.7 Ecological receptors comprising bog, heathland, trees and bird species cover the majority of DTA and are assessed as having a high sensitivity to site derived contaminants.
- 13.5.8 Grazing animals, predominantly sheep, roam the majority of DTA. As such they are likely to ingest site derived contaminants either through vegetation, which may have absorbed contaminants or via soil attached to the vegetation. Consequently it is assessed that grazing animals have a high sensitivity.

#### Potential Site Contamination

- 13.5.9 DTA encompasses an area of considerable size, and varying land use. The intensity of these past uses will be inherently variable and as such the spatial distribution and likely degrees of contamination will differ across the site. Camp areas are likely to comprise small well defined areas of contaminants. Ranges are likely to be characterised by generally lower concentrations of contaminants, which are sporadically distributed over a wider, poorly defined area. However several areas within the ranges, have been identified as containing potential sources, which are spatially well defined and likely to contain greater levels of contaminants. These are likely derived from more intensive use and includes small arms ranges and artillery target areas.
- 13.5.10 A further division can be made as to those sources of contaminants attributable to current and former MoD use and those formed by historical (non-MoD) use or natural characteristics of the area. Potential contamination caused by MoD use include use of fuels (primarily identified on Okehampton Camp), waste disposal (including Sewage Treatment Works (STW) and Ad Hoc tipping), electrical substations, old forges, incinerators and small arms ranges. It must also be assumed that, in the absence of any information to the contrary, there is a potential for contaminants to be present at the location of the former Willsworthy Camp. Long term use of explosive ordnance on the ranges, is also applicable to MoD use and may have led to a more widespread, low levels distribution of explosive residues and heavy metals. Non MoD sources of contamination include the more extensive distribution of heavy metals and radon gas associated with the natural geochemistry of the area. The legacy of historical mining activities will also present a potential source of heavy metals and acid mine drainage, which has the potential to effect both soil and groundwater.
- 13.5.11 To summarise it is assessed that the majority of DTA will be affected by relatively low level contamination with a widespread, irregular spatial distribution relating to both natural geochemistry or use of explosive ordnance. More significant concentrations are likely to be associated with limited source areas of contamination relating to both military and civilian use.
- 13.5.12 It should be noted that the assessment carried out in the LQA has not involved a comprehensive survey of the entire DTA. Rather it has sought to identify the most notable contaminants thought to be present, by appraisal of limited information. Assumptions on the distribution and presence of contaminants must therefore be qualified as being indicative of the issues likely to be present rather than a definitive representation of all potential contamination within the entire area.
- 13.5.13 It is also currently recognised that the potential for and risk posed by buried explosive ordnance has not yet been fully characterised and that this is an issue that requires further consideration.

### Significance Evaluation Methodology

13.5.14 The evaluation of significance is based on the risk assessment approach set out in the LQA Report. This approach considers sources of pollution, pathways by which a pollutant can move from the source and receptors (such as human beings and other living organisms, controlled waters, physical systems and built structures) which could be affected by the pollutant. The relationship between sources, pathways and receptors has been used to assess the potential environmental risk, which is based on the nature of the source, the degree of exposure of a receptor to a source and the sensitivity of the receptor.

### Assessment of Effects and Evaluation of Significance

13.5.15 The assessment has considered the potential effects identified in the Scoping Report, which included the following:

- effects from the historical and/or current storage and loss of motor fuels, aviation fuels, heating oils and other hydrocarbons;
- effects from the historical and/or current disposal of waste including broken/surplus material and explosive ordnance remnants (as both a detonation risk and a toxicity risk);
- effects from the historical and/or current use, storage and disposal of any other potential contaminating materials with potential for contamination of soils; and
- effects from historical and/or current shallow digging.

13.5.16 The following assessment has considered the potential effects in relation to each of the identified receptors.

### Humans

13.5.17 Current Human users of DTA comprising both military and civilian personnel are assessed as being subject to a generally low to moderate risk from identified contaminants.

13.5.18 Military users were in general assessed as having a low to moderate risk from contamination although moderate risks were thought applicable to the small arms ranges and identified areas of munitions use, contaminants associated with the deposition of mine wastes, organic vapours from POL installations on Okehampton Camp, and the demolished Willsworthy Camp. It is possible that all of these risks could be mitigated to a low risk by the use of appropriate Personal Protection Equipment (PPE) and application of suitable management procedures.

13.5.19 A high risk to MoD personnel is assessed with respect to radon gas in buildings, assuming that no current monitoring or management procedures are currently in place.

13.5.20 The risks posed by asbestos to MoD personnel are currently assessed as low to moderate with potential sources being unlikely to release fibres. This does however assume that adequate H&S procedures are adhered to in buildings where Asbestos Containing Material (ACM) has been identified. Risks could be reduced further to a low classification, with the implementation of an appropriate management plan, which is understood to be in the process of being compiled.

13.5.21 Non-MoD site users are characterised as either having a *moderate sensitivity*, where activities would lead to increased contact with soils and waters or *low sensitivity* where contact with soils and water is less likely

- 13.5.22 Where a *moderate sensitivity* is thought to be applicable, users are generally assessed as having a low to moderate risk, with the exception of sources including mine waste and the demolished Willsworthy Camp, where a moderate risk is assessed. Sources on areas used intensively by the MoD (e.g. small arms ranges and those on Okehampton Camp) were generally assessed as low due to the inherent access restrictions. Radon Gas is assessed as posing a high risk within enclosed buildings, although elsewhere the risk will be low.
- 13.5.23 For users with an assessed *low sensitivity* risks are generally reduced to an assessment of low.

#### Surface and Groundwater

- 13.5.24 Surface water, used for potable water abstraction throughout the area, were assessed as having a generally low or negligible risk although this rises to moderate with respect to tin mining waste.
- 13.5.25 Groundwater is also used for potable water abstraction within the site and in surrounding areas. The site is underlain by a Minor Aquifer, and a low to moderate risk has been assessed for the majority of the larger sources identified. The exceptions to this include the current and former POL and infilled quarry, both of which are on Okehampton Camp which are assessed as having a moderate risk. A moderate risk applied to the demolished Willsworthy Camp is attributable to a lack of information on the former infrastructure.

#### Buildings and Buried Services

- 13.5.26 The risks to current buildings and buried services are assessed to be negligible to low across the site.

#### Grazing Animals

- 13.5.27 Risks to grazing animals are assessed as generally low although moderate risks were assessed with respect to identified sources of potential contamination including areas of munitions use, such as small arms ranges former artillery targets, as well as areas of mine waste and the STW outfall adjacent to Okehampton. The potential for uncertainty over contaminant distribution was also assessed as requiring a moderate risk with regards to the demolished Willsworthy Camp and unidentified contaminants on the ranges.

#### Ecological Systems

- 13.5.28 Ecological systems (fauna) were assessed as having a generally applicable risk assessment of low to negligible. In areas of identified contamination, likely to be found in significant concentrations, which fall within ecologically designated areas a moderate risk was applied. This related to both occurrences of mining waste as well as the Small Arms Ranges on Willsworthy and former artillery targets found across the Okehampton, Willsworthy and Merrivale Ranges as well as the demolished Willsworthy Camp. Plants (flora) were similarly found to be generally at low to negligible risk from identified contaminants although as with fauna a moderate risk was applied with respect to mining waste as well as the Small Arms Ranges on Willsworthy and former artillery targets.

#### Unexploded Ordnance

- 13.5.29 The historic use of DTA for live firing has resulted in the presence of unexploded ordnance (UXO) under parts of the moor.

#### Definition of Ordnance

- 13.5.30 MoD defines UXO as '*Ordnance which has been primed, fused, armed or otherwise prepared for action, and which has been fired, dropped, launched, projected or placed in*

*such a manner as to constitute a hazard to operations, installations, personnel or material and remains unexploded either by malfunction or design or for any other cause.'* [Ref. JSP 403]

- 13.5.31 Evidence of live firing has been found dating back to the mid 19<sup>th</sup> century and by 1895 artillery training was being undertaken on Okehampton Range. In the early 1900's Willsworthy Range was acquired and its fixed ranges established. During the Second World War the entire moor was used for live firing.
- 13.5.32 Ground conditions across a large part of the unenclosed moorland consist of peat varying from some 50cm to over seven metres in depth. The combination of climate and ground conditions can result in significant movement within the peat layers as this material expands and contracts in response to soil moisture and temperature. As a result items of UXO can migrate to the surface.

#### *Risk Management*

- 13.5.33 UXO presents a hazard to walkers, riders etc if impacted. However, the MoD view is that if UXO did not explode when fired or detonate on landing then it is therefore unlikely to explode without considerable physical force or heat being applied. That said management procedures are in place to minimise the potential risks associated with UXO.
- 13.5.34 The existing controls applied comprise:
1. providing information to users of DTA using leaflets, weekly newspaper notices, information boards, signs on boundary poles around the present RDA warning of the hazard and advising that if found military debris should be left alone, a note made of the location, the area marked and to inform the police or Commandant DTA;
  2. searching areas used for training after each exercise to collect expended military debris and to report any UXO found;
  3. carrying out periodic sweeps of the designated training area to ensure that they are free of military debris;
  4. briefing DNPA Rangers and guided walk leaders on the action to be taken if UXO are found; and
  5. informing, as part of the Junior Life Skills, Year 6 pupils in the WDBC catchment area of the hazards and action to be taken should UXO be found.

#### *Future Management*

- 13.5.35 Active clearance of UXO has been undertaken and historical clearance records held by MoD dating back to 1900 indicate the extent of clearance tasks. The locations are summarised in **Table 13.2**, below.

Table 13.2 UXO Clearance

Location	Grid Reference	Area cleared (ha.)
Great Mis Tor	SX 563, 769	44.0
Oke Tor	SX 612, 901	16.0
Scary Tor	SX 607, 925	17.78
Kitty Tor	SX 567, 875	16.0
Bagga Tor	SX 558, 798	2.0
Row Tor	SX 593, 917	18.5
Henry's Ford Bivouac Site	SX 579, 913	1.0
Red-a-Ven Brook Bivouac Site	SX 605, 911	1.0
Oxheadwater Bivouac Site	SX 609, 889	1.13
Sammy Arnold's Bivouac Site	SX 603, 389	2.1
Dinger Tor Bivouac Site	SX 587, 881	1.68
Knack Mine Bivouac Site	SX 614, 886	2.9
<b>Total</b>		<b>124.09</b>

## Notes

1: At Little Mis Tor (grid ref. SX 563, 763) 129.01 ha. has also previously been cleared, although there remains the possibility of unexploded ordnance in this area

13.5.36 Other areas of historic clearance have also occurred to varying extents but again these cannot be considered comprehensive due to the narrow width of areas covered and the potential for UXO movement within the peat.

13.5.37 Consideration has been given to the actions required to achieve complete clearance of UXO on DTA. In order to achieve complete clearance, visual searches followed by non intrusive geophysical surveys to establish the presence of remaining UXO, would be required. The surveys would need to be followed by excavation and removal. This would result in temporary disturbance of ecologically sensitive habitats and the further need to manage the regeneration of the vegetation in areas affected. In addition, and importantly, the ongoing movement within the peat would result in the need for repeat operations. Due to the extent of land involved, i.e. the whole of the DTA, the MoD estimate that the process could take up to forty years to complete.

13.5.38 The disadvantages of clearing DTA are considered by MoD to be that:

- no device exists that will allow assessment to be made of the density of UXO;
- clearance needs to be by location and then digging out the UXO before deciding whether it is dangerous and needs blowing or is expended;
- it is impossible to be certain that all UXO has been cleared;

- bogs and rivers cannot be searched or completely cleared;
- peat would be damaged by digging down to investigate UXO and therefore, the clearance itself would cause effects on nature conservation sites;
- clearance activities could also effect cultural heritage features which would therefore have to be avoided;
- access to the areas to be cleared for machinery would be potentially damaging to the landscape; and
- workers undertaking clearance work would require huts etc to be erected to comply with HSW which would also effect landscape quality.

13.5.39 Given the extent of the task and taking account of risk, clearance as a single project (as opposed to ongoing removal of UXO that becomes visible), is not considered by MoD to be feasible. For the purpose of this EA, it is therefore assumed that conditions, in terms of the presence of UXO, will not change significantly in the future.

## 13.6 Summary of Significance Evaluation

13.6.1 The majority of DTA is considered to have widespread, sporadically distributed contamination at generally low levels relating to both military (use of explosive munitions) and non-military use (natural geochemistry & tin mining). Smaller more localised areas, more likely to contain higher levels of contaminants have also been identified which are attributable to military use.

13.6.2 It should however be considered that the majority of contaminants are derived from historical practices and current and future use is likely to present a significantly lower possibility of allowing contamination.

13.6.3 The suitability of continued military use of DTA is therefore based on the premise of managing the existing, historical liabilities and the likelihood of future contamination. The former may be dealt with by the measures proposed in a technical note (Entec Ref R07286i1). These involve both better characterisation of potential higher risk sources as well as the application of measures of good practice (e.g. use of appropriate PPE for those involved in groundworks, asbestos management, controlled access to certain areas of contamination, formalised risk assessment of buried ordnance, and further characterisation of suspected contamination). If such management measures are employed these issues should not hinder future military use.

13.6.4 To conclude it is assessed that DTA is suitable for continued military use, in the form outlined if suitable management of identified risks is implemented.

13.6.5 A summary of the significance of effects in relation to each of the identified receptors is outlined in **Table 13.3** below.

Table 13.3 Summary of Significant Effects

Receptor and summary of predicted effects	Type of effect <sup>1</sup>	Significance <sup>2</sup>	
Humans (the public and military users): Contact with contamination through trench digging (military only), walking, climbing, farming etc resulting in health effects	-ve	NS	The risk to military personnel is considered to be low to moderate - moderate <u>without mitigation</u> but low <u>with mitigation</u> in place. The risks to non MoD personnel is considered to be low but low to moderate where such personnel come into greater contact with soils and water particularly close to areas of mine waste and the demolished Willsworthy Camp.
Surface and groundwater: pollutant effects from contamination migrating through or over the ground to contaminate water	-ve	NS	The risks to surface water (used for abstraction) are low/negligible except in areas close to tin mining waste (moderate) Risks to groundwater (used for abstraction) are low to moderate across most of DTA except within Okehampton Camp and Willsworthy Camp (moderate risk)
Buildings and buried services	-ve	NS	Risks are low/negligible
Grazing animals: health effects from direct contact with soils, consumption of vegetation in areas of contamination	-ve	NS	Risks are low but moderate in areas of identified sources of potential contamination (areas of munitions use, mine waste, STW outfall, Okehampton, demolished Willsworthy Camp and on the ranges).
Ecological systems: effects on growth of flora from presence of contamination in ground and on fauna from consumption of vegetation grown in contaminated soils.	-ve	NS	Risks to fauna and flora are low/negligible but moderate where areas of identified contamination lies within designated sites (mining waste, small arms ranges, former artillery targets, demolished camp).
Unexploded ordnance: risk effects on humans coming into direct contact with UXO.	-ve	NS	Existing management measures are considered to minimise the risks associated with UXO to an acceptable level.
<b>Key/footnotes:</b>			
1.Type of effect	-ve = negative + ve = positive N = Neutral ? = unknown	2.	S      Significant or NS      Not-significant

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