Ministry of Defence

Report of a Reconnaissance Visit to Develop an Enhanced Environmental Monitoring Programme in the British-led Sector in Kosovo

Issued on behalf of the Ministry of Defence by

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SUMMARY

This paper describes the results of a reconnaissance visit to Kosovo to scope the requirements for the enhanced environmental survey programme announced by the Minister for the Armed Forces in Parliament on 9 January 2001. Although the announcement was made in response to veterans' concerns over the possible risks from depleted uranium (DU) munitions used by NATO Forces in the Balkans, the risks from other hazardous materials have not been neglected. There is already an established health and safety and environmental health regime in Kosovo and Army Environmental Health Teams in the area have identified potential risks related to air quality, heavy metals and asbestos. Assessments of the potential risks from the use of DU munitions were made before UK troops entered Kosovo and were assessed as very low. Although subsequent findings have confirmed the validity of this initial assessment, there is clearly a need for further work to address veterans' concerns.

The findings from the reconnaissance parallel those by other NATO partners and international organisations. DU contamination was found to be limited and very highly localised and no contamination was detected in the vast majority of locations surveyed. However the need for a more thorough assessment of the potential risks from low levels of caesium contamination that probably results from the Chernobyl accident was identified. The visit also highlighted some of the practical problems likely to arise during future survey work. These include uncertainty regarding the exact location of DU attacks and the presence of other known physical and environmental hazards such as unexploded ordnance and asbestos. The paper also indicates that surveys for radiological contamination provide opportunities for gathering information on other hazardous materials (such as heavy metals) at little additional cost.

CONTENTS

INTRODUCTION AND BACKGROUND

Introduction

1. In April 1999, as troops prepared to enter Kosovo in support of peacekeeping operations, it was recognised that UK troops might come into contact with debris from Depleted Uranium (DU) munitions. On 20 April, DERA Radiation Protection Services (DRPS) who are the Ministry of Defence's Radiation Protection Adviser prepared a note for the Surgeon General's Department (SGD) on the potential risks from DU munitions and the means by which these risks could be managed. SGD are responsible for occupational health and safety in operational theatres and the Ministry of Defence was advised on 11 June 1999, before UK troops entered Kosovo, that appropriate DU safety guidance had been issued (Reference 1).

2. In parallel with this, DRPS were maintaining regular contact with Explosives Ordnance Disposal (EOD) personnel at the Permanent Joint Headquarters (PJHQ) at Northwood. PJHQ are responsible for controlling activities in an operational theatre and it was recognised that EOD personnel, who are required to deal with ammunition and explosives disposal, were the group most likely to come into contact with DU residues for protracted periods. The original assessment was that the risk of UK troops coming into contact with DU residues was low and this was confirmed during the following weeks and months as PJHQ continued to report that no indications of DU usage had been discovered in the UK sector. Final confirmation of the very low risk was received when NATO sources advised that DU munitions had only been fired at 8 locations in the UK sector.

3. Following claims of an alleged excess of leukaemia amongst Italian troops deployed in the Balkans, media reports in January 2001 postulated that this was linked to the use of DU munitions during the Kosovo and Bosnian conflicts. These claims led to a general concern in Europe over the potential health effects of DU, both on the local civilian population and on participating Servicemen. As a result of these concerns, on 9 January 2001 the Minister for the Armed Forces announced that the Ministry of Defence would identify an additional appropriate voluntary screening programme for troops and civilians who had served in the Balkans and would enhance the existing environmental surveillance programme (Reference 2). To implement this policy decision, military and civilian staff from several Ministry of Defence

Departments, including DRPS, made a reconnaissance visit to Kosovo during the period 19-23 January 2001 to scope future environmental monitoring requirements. Responsibility for organising the enhanced environmental monitoring programme has been given to MOD's Chief Environment and Safety Officer (CESO(MOD)) and the reconnaissance team was headed by a member of the Health Physics Section of the Directorate of Safety, Environment and Fire Policy (D SEF Pol) which provides the focus for radiation protection policy within the Ministry of Defence. This paper reports the findings from that visit.

4. Although this report focuses on potential radiation hazards, and especially those from DU, other health hazards of potentially much greater significance such as smoke, lead and asbestos have been identified in Kosovo by Royal Army Medical Corps (RAMC) Environmental Health Technicians and Officers who form part of the UK contingent. Of particular concern are emissions from the lignite-fuelled power stations near Pristina and from some parts of open-cast lignite mines which are on fire. These sources of environmental pollution are shown in Annex A. The lack of civil infrastructure has resulted in rubbish being dumped by the roadside or in ditches and people are scavenging and salvaging metal from scrap vehicles and rubbish dumped in the fields. There is also little evidence of an effective public water supply or sanitation in some areas and many families draw water from wells using hand pumps. A lead smelter at Mitrovica is a source of lead and other heavy metal pollution and there has been widespread use of asbestos in building materials.

5. These other potential hazards were also considered during this visit and RAMC personnel formed an integral part of the reconnaissance team. The wider environment and occupational health issues will not be discussed in detail, but a summary of the RAMC findings and some comments on toxic or other hazardous materials found in areas where enhanced levels of radioactivity were discovered are included in the report for completeness. A secondary task carried out by the reconnaissance team was the collection of samples or data that might be of use in the DU research programme being formulated by the Ministry of Defence's Chief Scientific Adviser.

Source of the DU

6. The DU munitions used during the Kosovo and Bosnian conflicts were fired by US A-10 (Warthog) aircraft attacking ground-based targets - principally armoured vehicles. DU is particularly effective in this role because of its high density and its ability to "self-sharpen" rather than "mushroom" as it penetrates armour plate. A more detailed description of the A-10, its DU ammunition and mode of attack is provided in Annex B. The most important facts are that several hundred DU rounds will be fired per attack and that a substantial proportion of this ammunition will penetrate the ground around the target. This will occur as a result of rounds missing the target or passing "through" targets other than Main Battle Tanks. Estimates of the depth of penetration depend on soil type and the presence of rocks and vary from 0.5 to 5.0 metres. Each DU penetrator weighs approximately 300g and is about 100mm long and 16mm in diameter.

Potential health risks

7. DU is a low specific activity radioactive material and is chemically toxic to about the same extent as lead. DU fragments, dust and aerosol (in the form of various oxides) are generated to various degrees when DU penetrators hit targets or are subjected to intense heat from vehicle or munitions fires and health risks arise from the possible inhalation or ingestion of this material or from contamination of wounds. DU dusts and aerosols can also be re-suspended by personnel working inside damaged or burned out contaminated vehicles or by wind, personnel or vehicle movement over contaminated ground. The potential risks from DU munitions have been addressed in many comprehensive reports listed in References 3 – 7.

Locations where DU munitions were used

8. Prior to the reconnaissance visit NATO sources confirmed that there were 8 locations in the British sector in Kosovo where DU munitions had been used. These locations are shown on the map in Annex C and are summarised in the table below. One of these locations is close to an area where there is Temporary Field Accommodation (TFA) for British troops and visiting this area was a priority for the reconnaissance team. One site where DU had been used (see below) could not be

visited because of problems in reaching the site and the opportunity was taken to visit the major UK base at Slim Lines.

Site Description	**Mission Number**	**Date of Attack**	**Rounds Fired**	**Number of DU Rounds**	**Grid Reference** (linked site reports)
Waterloo Lines	4125F	29 May 99	350	219	34T EN 178432
Former Barracks	2467F	11 May 99	700	438	34T EN 187470
Site near Glogovac	4260F	8 Apr 99			34T DN 834190
Farm and Fields	2401F	7 Jun 99	370	231	34T DN 886168
Pine Wood – Stimlje	3102F	11 May 99	150	94	34T EM 019990
Hill Top	3371F	22 May 99			34T EN 209103
Route Snake	1503FA	10 May 99	200	125	34T EN 148478
Not visited – see text	4123F				34T EN 1700 29

SURVEY STRATEGY AND EQUIPMENT

Strategy

9. The purpose of the reconnaissance visit was to gain an understanding of conditions in Kosovo that would assist in the development of future environmental monitoring strategies and prove the UK capability to detect DU residues at sites where DU munitions were known to have been used. Monitoring at locations where DU munitions were used also provides an indication of "worst case" conditions and assists in setting an upper bound for the potential risks.

Monitoring equipment

10. The principal monitoring equipment used was the Exploranium Mini Spec GR130M surveying gamma ray spectrometer. This instrument was used in survey mode (in which raw counts from the detector are displayed as a function of time in a bar chart display), in the dose rate mode (with a sensitivity down to nanosieverts per hour) and as a low resolution gamma spectrometer. Mini Instruments Model 900 ratemeters with Type 44B low energy X-ray probes were also available. All monitoring was carried out with the instruments as close as possible to the ground surface.

Survey procedure

11. The survey procedure involved the collection of data on the location and size of UK bases and on the source of water supplies and foodstuffs. In areas where DU munitions had been used, walkover surveys were carried out with the GR130M being used in survey mode to provide an indication of average radiation levels and evidence of enhanced radioactivity. Monitoring was also carried out with the Type 44B probe and soil samples were collected for subsequent radiochemical and chemical analysis. Given the preliminary nature of the work, the walkover surveys were random rather than systematic (in as much as the monitoring was not carried out along designated transects) and was concentrated on areas where there were visible signs of battle damage.

SURVEY RESULTS

General

12. Only seven of the eight sites where DU munitions had been used in the UK sector could be visited during the reconnaissance, as the eighth was inaccessible by road. As already indicated, most attention was given to the DU attack site that was close to a British TFA site known as Waterloo Lines. More extensive and detailed monitoring was also carried out at a former Yugoslavian Army barracks where some DU penetrators and sabot/windshield fragments were recovered. Damaged asbestos construction materials appeared to be dispersed around the site where the DU penetrators were found and subsequent laboratory analysis confirmed the presence of chrysotile. For completeness, a detailed summary of the findings at each site is given in Annexes D – J and a summary of the findings and recommendations of the Army Environmental Health Team are included at Annex K.

Field monitoring results

13. There was only one location where the presence of DU was confirmed. This was at a former military site known as Old VJ Barracks where 3 penetrators and sabot and/or windshield fragments were located. Photographs and the results of visual examinations of the recovered material are shown in Annex L. Personnel equipped with the Type 44B probe found one penetrator and its sabot lodged in a brick wall behind 1 - 2cm of debris; another was discovered protruding from concrete building foundations during a visual inspection of battle damage; and the third was found under approximately 200mm of debris by personnel using the GR130M in survey mode. Some localised areas of enhanced gamma activity measuring about 30 X 30cm were detected at Old VJ Barracks site and at the site of another DU attack north of Glavnick. Gamma spectrometry carried out with the GR130M confirmed that the penetrators recovered were made of DU and a spectrum of the gamma ray emissions discovered at Glavnick suggested that the increased activity was due to the presence of caesium–137. The discovery and identification of caesium-137 with the Exploranium was not anticipated prior to the visit and shows the value of portable gamma spectroscopy equipment.

Analysis results

14. Twenty soil samples and four samples of debris from around the recovered penetrators were collected with a trowel and taken to the UK for more detailed analysis. A sample of what appeared to be fly ash discharged from the power station was also collected. The samples underwent an initial screening by gamma spectrometry to check for the presence of caesium-137 (as detected in the field with the Exploranium) and any other gamma emitters. Gamma spectrometry can also give an indication of gross contamination by uranic materials, but the limits of detection are high and the usefulness of the technique is dependent on the sample matrix. It is not sufficiently sensitive for measuring uranium at typical environmental levels. In this case the primary purpose of the measurements was to ensure that elevated levels of gamma emitters did not present a contamination risk in laboratories where more sophisticated low level analyses were to be carried out. The detailed gamma spectrometry analysis results are in Appendix 1 and the principal findings are discussed below.

15. Caesium-137 was detected in the soil sample from Glavnick and in most other soil samples. The activity concentrations of caesium were highly variable and ranged from not more than 1 - 1241Bq/kg. Caesium-134 was also found in some samples and the ratio of the activities of caesium-134 and caesium-137 suggests that the material is likely to have been deposited as a result of the Chernobyl accident. There were also indications of elevated levels of uranic materials in three samples all taken from the immediate vicinity of the recovered penetrators. In the one instance in which both uranium-235 and uranium-238 were present at levels above the limit of detection, the uaranium-235 to uranium-238 isotope ratio confirmed the presence of depleted rather than natural uranium.

16. The intention had been for the soil samples to be submitted for more sensitive forms of uranium analysis using techniques such as X-ray fluorescence (XRF) and inductively coupled plasma mass spectroscopy (ICPMS). However the presence of asbestos in some samples has delayed this work because of concerns over the possibility of asbestos fibres being released into the atmosphere during sample homogenisation. As an interim measure, further analysis by alpha spectrometry was carried out on seventeen samples in a suitably equipped laboratory.

17. The alpha spectrometry results are shown in Appendix 2. The results confirm that DU is present in samples from materials that were immediately adjacent to locations where penetrators were recovered, however there is no indication of significant contamination in the wider environment. Uranium isotope levels are generally typical of those for naturally occurring uranium in soil where uranium-238 is generally present at an activity concentration of less than 20Bq/kg. Furthermore, the ratio of the activities of uranium-234 and uranium-238 is about 1.0 which is consistent with the uranium being from naturally occurring sources. The finding that DU contamination is highly localised is entirely consistent with the results of other surveys such as those carried out by the United Nations Balkans Task Force (Reference 4).

Significance of the analysis results

18. The significance of the analysis results may be judged by comparing the measured activity concentrations with the National Radiological Protection Board's Generalised Derived Levels (NRPB's GDLs) for caesium-137 and uranium isotopes in soils (References 8 and 9). Using pessimistic assumptions, it has been calculated that continuous exposure at the GDL results in a person receiving an annual radiation dose of 1 millisievert (mSv) which is the current UK statutory dose limit for a member of the public. The corresponding annual dose limit for employees is 20mSv (Reference 10).

19. NRPB recommend that activity concentrations in excess of 10% of the GDL require further investigation to assess the applicability of the dose modelling to the actual scenario at the location of interest. Two of the caesium-137 activity concentrations in the samples collected exceed the GDL (of 1000Bq/kg) and this confirms the need for some further investigations during future survey work. However, the average activity concentration for all soil samples is well below the GDL and the concentrations in soil from locations close to the British camps at Waterloo Lines and Slim Lines are 98 and 11Bq/kg respectively and less than 10% of the GDL. The corresponding GDLs for uranium in well-mixed soil are 20000, 7000 and 20000Bq/kg for uranium-238, uranium-235 and uranium-234 respectively. With the exception of samples taken from locations immediately adjacent to DU penetrators, the alpha spectrometry results confirm that typical levels of uranium isotopes in soil are generally only 0.1% of the GDL.

Further analysis work

20. As already stated, the intention is to carry out more sophisticated analysis of the samples by XRF and by ICPMS so that more precise information can be obtained on the uranium isotope ratios. The use of XRF is particularly useful as the samples can be analysed for other heavy metals for little additional cost. This will provide information useful for the wider examination of occupational health issues described above. The removal of asbestos from the samples is now being carried out by a suitably qualified and accredited laboratory so that the samples can be certified free from asbestos and submitted for further analyses without the need for specialist precautions.

Accuracy of mapping

21. A major finding from the reconnaissance visit was that the accuracy of the map coordinates for the locations where DU was used are only accurate to plus or minus 1 nautical mile and that the chances of detecting DU in such a large area are very low unless there are other visual indications of the point of attack. Such indications existed at the Old VJ Barracks site, where there were a number of buildings showing signs of battle damage. This focussed attention on this area and triggered the subsequent discovery of DU penetrators during the radiation monitoring survey. Field measurements with the Exploranium indicated that detection of a DU penetrator buried under much more than 150mm of soil was unlikely. In air, detection was just possible over a distance of about 400mm. The obvious conclusion is that penetrators are unlikely to be detected by the use of radiation monitoring equipment unless they are on or close to the surface. This finding should be contrasted with information from US sources that indicates that DU rounds from A-10 aircraft are likely to penetrate 0.5 - 5m into the soil. The exact depth is difficult to predict as it depends on the soil conditions and the aircraft's approach.

Hazardous materials other than DU

22. There was evidence of asbestos contamination at the Old VJ Barracks site and the presence of chrysotile asbestos was confirmed by subsequent laboratory analysis. Discussions with Theatre Environmental Health Technicians revealed that the

widespread use of asbestos in building materials in the Balkans was well known. RAMC advice is that the presence of the asbestos makes further work at this site problematical, as any future investigation would inevitably involve disturbance of asbestos contaminated ground. Conditions were wet and there was negligible risk from resuspended asbestos fibres during the reconnaissance visit, but this would not be the case during drier weather. Removal of the asbestos prior to a DU survey would almost certainly require stripping of the topsoil to a depth of 150 - 300mm and this could destroy much of the evidence relating to DU.

23. Unexploded ordnance is also a major issue at some locations where DU munitions were used. Army Explosive Ordnance Disposal (EOD) teams were required to lead the search in these areas and progress was very slow. At one site it took about 20 minutes to progress 20m linearly into the wood and monitoring and sampling was difficult because of the restricted area of cleared ground. Access was attempted using an armoured personnel carrier (APC), but this was of limited usefulness in terms of access through woods and access to the ground for monitoring and sampling purposes. Surveying such areas on foot or using an APC would clearly not be practicable.

CONCLUSIONS

24. The reconnaissance visit has highlighted certain key issues that need to be borne in mind when considering the proposals for the environmental survey. Whilst the reason for the survey is in response to concerns about DU, the issue of caesium-137 contamination also needs to be properly addressed. However, any proposals for environmental surveys need to be considered in the wider context of risks arising from other hazards in the Kosovo theatre. Two such hazards identified during the visit were unexploded ordnance and asbestos. These hazards must be considered as part of a comprehensive generic risk assessment, which will be required to be completed before the survey mission commences and will need to be reviewed in Kosovo in the light of local circumstances.

25. The data obtained during the reconnaissance visit is in good agreement with that reported by other NATO countries and organisations such as the United Nations Environment Programme (Reference 4). The data supports the initial assessment that the risks to UK troops are low as areas affected by the use of DU munitions are widespread and significant levels of DU contamination highly localised. The fact that most of the DU recovered was in the form of intact penetrators, even in the case of the penetrator that had hit a concrete slab, suggests that there is little DU dust produced when a penetrator misses its intended target. Given that a US Government report (Reference 5) suggests that only 10% of the DU rounds fired by A-10 aircraft hit the intended target and that trials have shown that only a percentage of the DU is converted into a respirable form, the amount of DU available for inhalation even during an attack is obviously less than 10% of the total. Those at greater distance would obviously be at less risk as the dust is diluted and dispersed by the wind and weather.

26. The fact that the penetrator found on the ground had corroded to a greater extent than those embedded in building materials is not surprising. What the finding does indicate however, is that the corrosion of DU takes a finite time and that this must be allowed for when assessing the possible environmental or health consequences. Further investigations of the rate of corrosion and nature and mobility of the corrosion products would allow more sophisticated risk assessments.

27. Areas of DU contamination are widely dispersed and there is a likelihood that DU munitions residues may not be found even when approximate grid references of

attack locations are known. Therefore the maximum amount of documentary, visual and even anecdotal evidence needs to be collated in advance if there is to be a realistic chance of finding DU munitions residues on former battlefields.

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General Environmental Health Issues

Power Station near Pristina

Burning lignite in open-cast mine

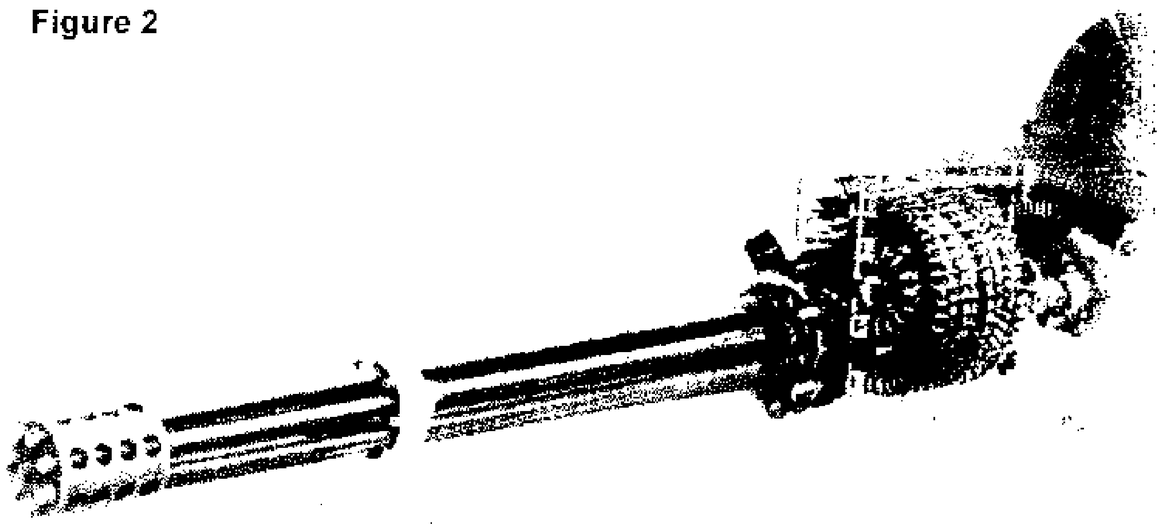
Annex B

The A-10

The A-10 (Fig 1) is a US aircraft that uses a 30mm, Gatling gun (Fig 2) with a rate of fire of 65 rounds per second to attack ground targets. The gun is generally fired in 2 – 3 second bursts. The ground area affected depends on a number of factors (such as the aircraft's angle of approach) but is generally taken to be about 500 – 1000 square metres.

Figure 1

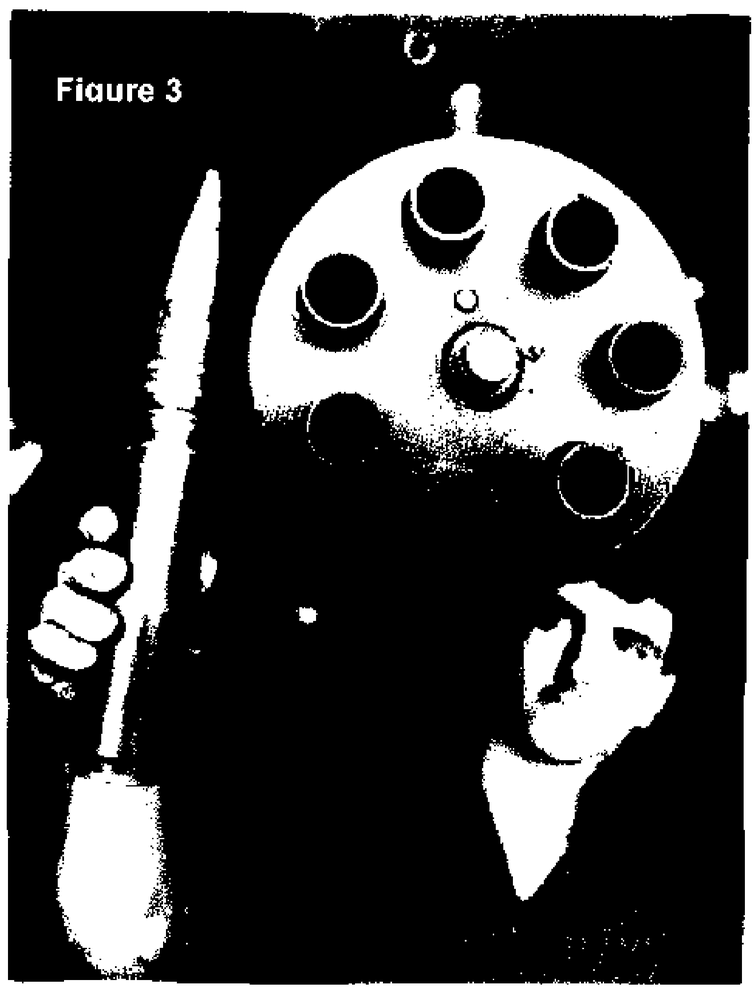
Figure 2



The primary purpose of the A-10 is to attack armoured targets and the typical combat load is 1100 rounds, consisting of both, armour piercing incendiary (API) and high explosive incendiary (HEI) rounds.

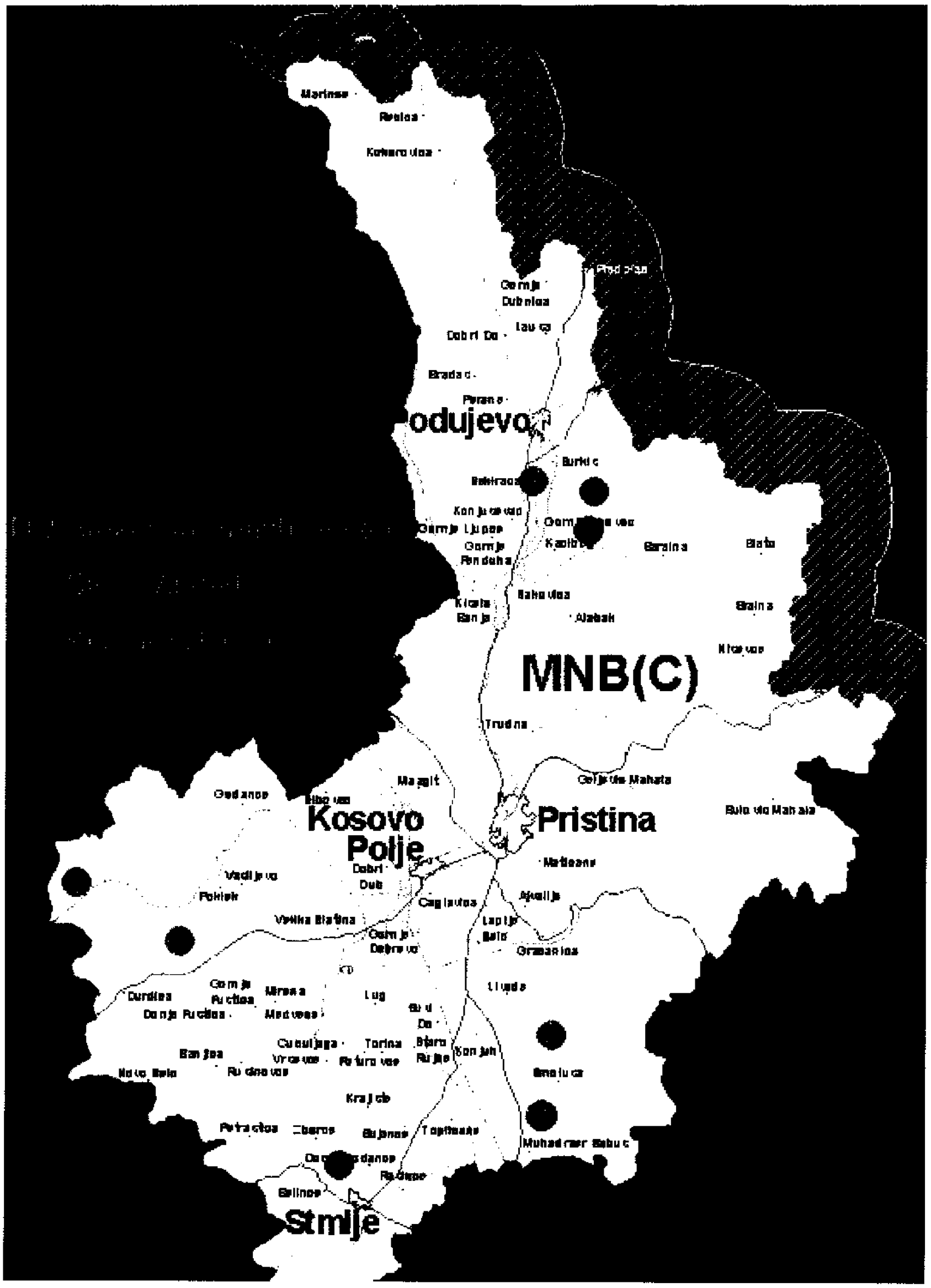
The 30mm API round (Fig 3) contains a nominal 300 grams of DU in a rod known as a penetrator. The DU is contained within a lighter alloy casing that is sometimes described as a nosecone, windshield or sabot.

Figure 3



Annex C

Locations where DU munitions were used in the UK Sector



Annex D

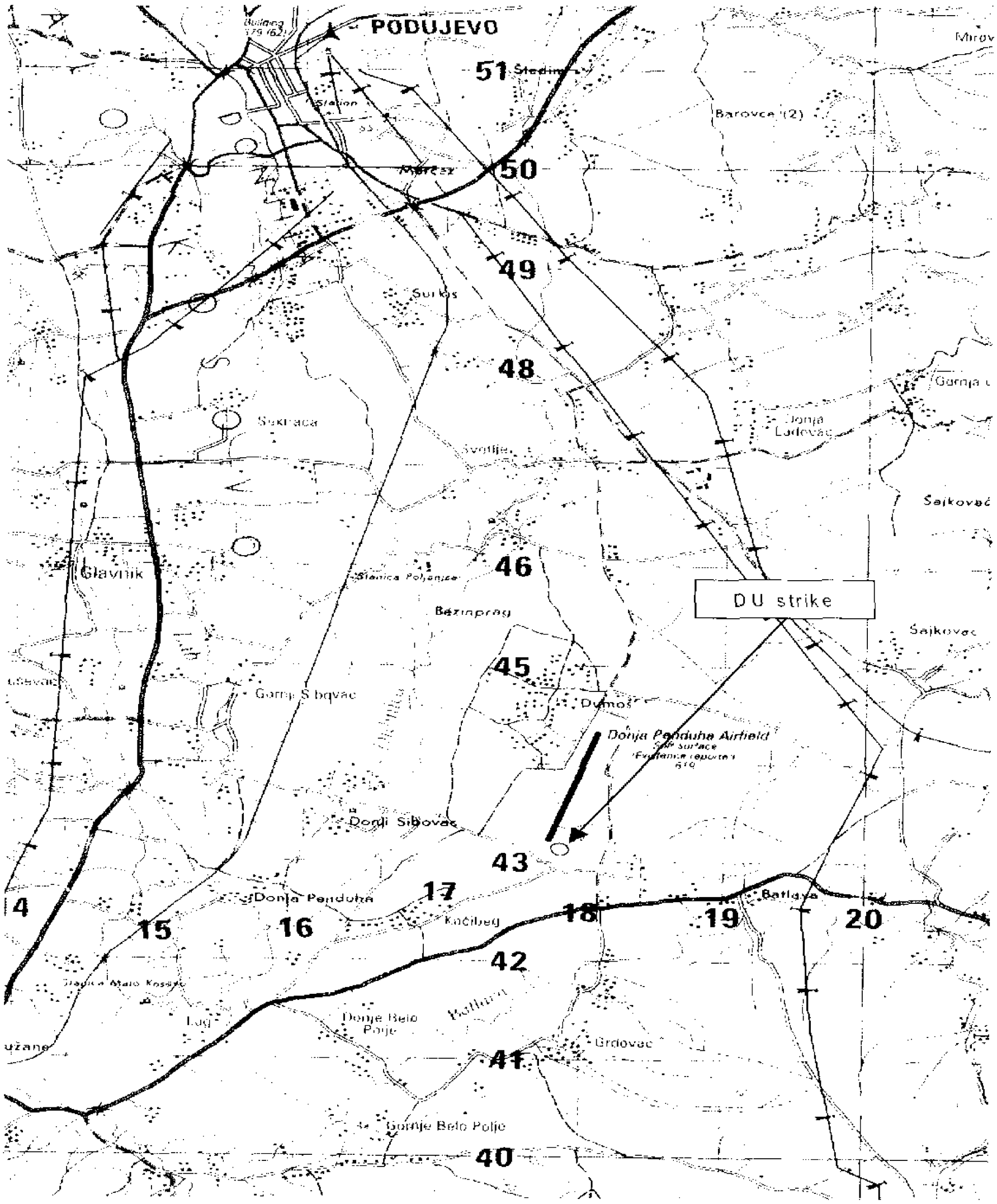
Site Visited - Waterloo Lines

Details of Attack

Mission Number	Date	Rounds Fired	Number of DU Rounds	Grid Reference	Target	Result
4125F	29 May 99	350	219	34T EN 178432	3*APC	Decoy

APC = Armoured Personnel Carrier

Map showing the location of the DU attack



Site Description

This site was a former Yugoslavian military grass airfield and is now a large British base. During construction of the base, soil was moved from an area around the grid reference of the attack location and there is a risk that this soil may have been contaminated with DU. The area has since been covered with extensive concrete hard-standing (Fig 1) and the excavated soil spread over a field next to the base (Fig 2).

Figure 1

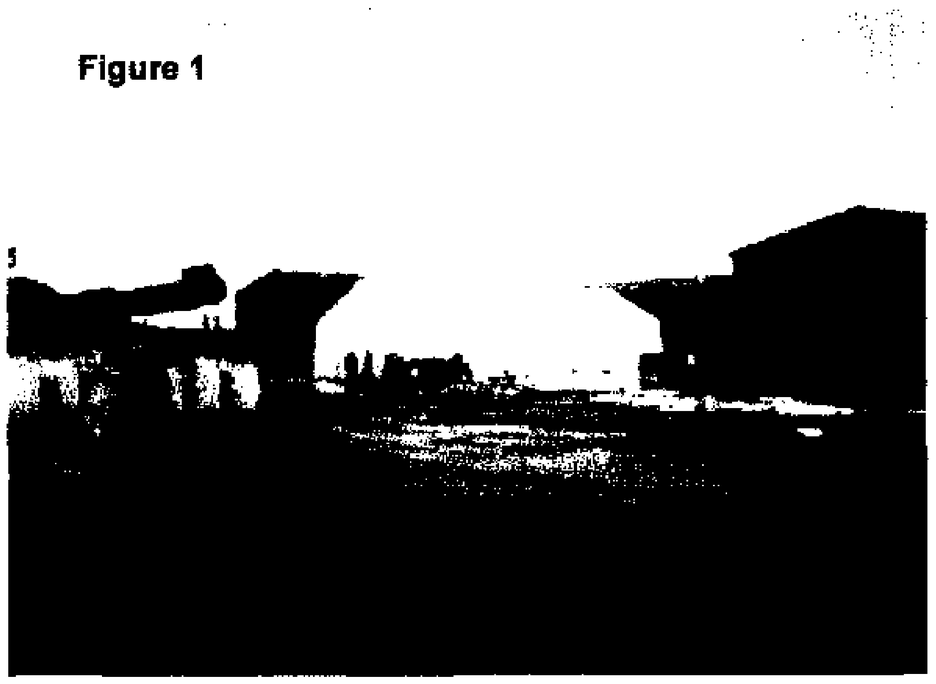


Figure 2

Radiation measurements

Inside Waterloo Lines:
In soil by main drainage ditch: 80nSv/h
On top of concrete hard-standing by Rubb Hall: 35nSv/h

Outside Waterloo Lines:
Area where excavated soil was dumped: about 80nSv/h over a wide area with no significant variations.

No significantly enhanced readings found.

Soil samples

A sample of soil was taken inside the base beside the concrete hard standing (Fig 3) and a further sample was taken from the area where the excavated soil had been dumped (Fig 2). A third sample was taken from near the excavated soil and on the edge of a field used for growing maize.

Figure 3

Soil sample identity numbers

1B061010 – W1. By hardstanding.
1B061011 – W2. Excavated soil.
1B061012 – W3. By maize field.

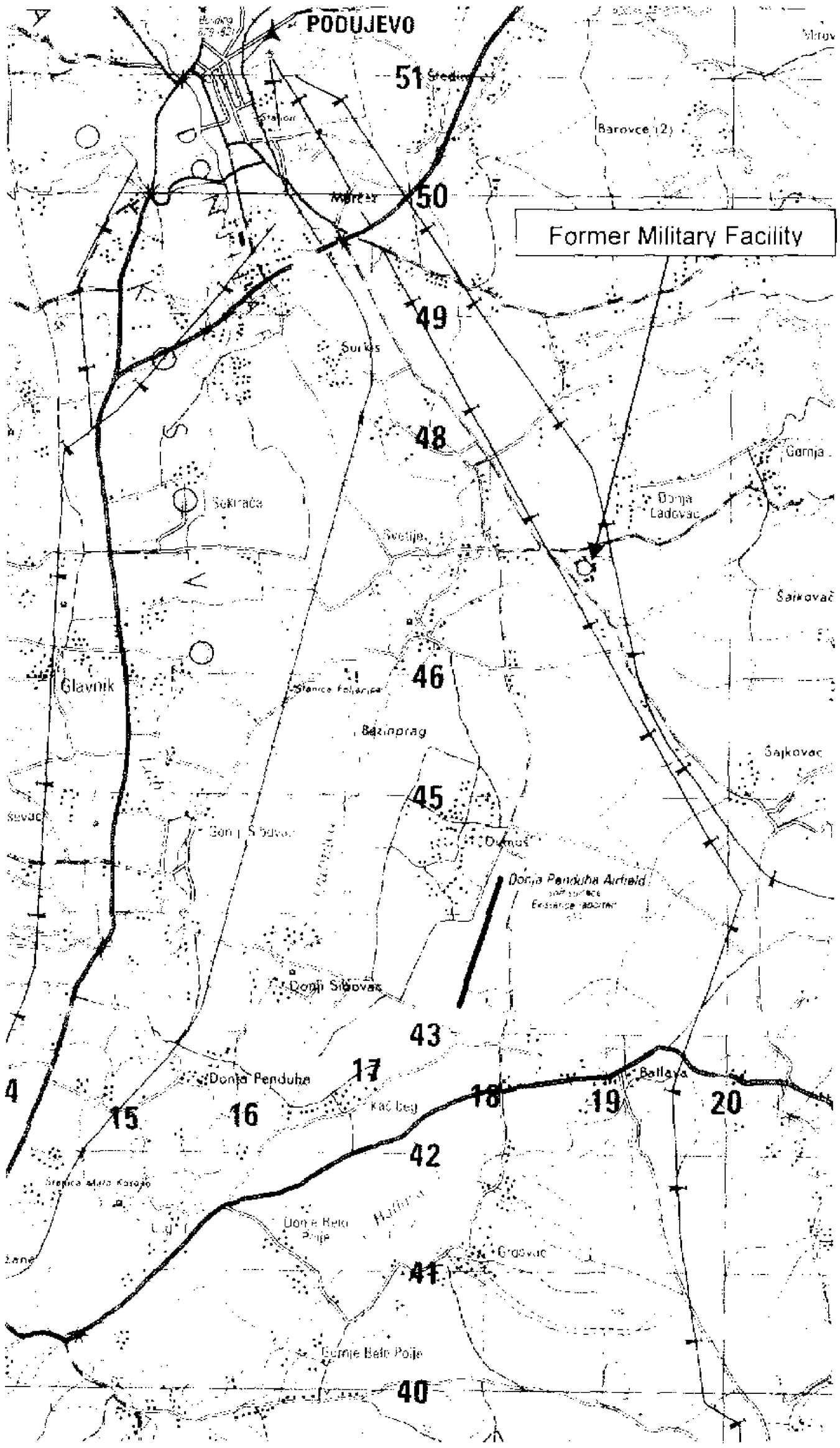
Annex E

Site Visited - Former Yugoslavian Military Barracks

Details of Attack

Mission Number	Date	Number of rounds	Number of DU rounds	Grid Reference	Target	Result
2467F	11 May 99	700	438	34T EN 187470	Building	Hit

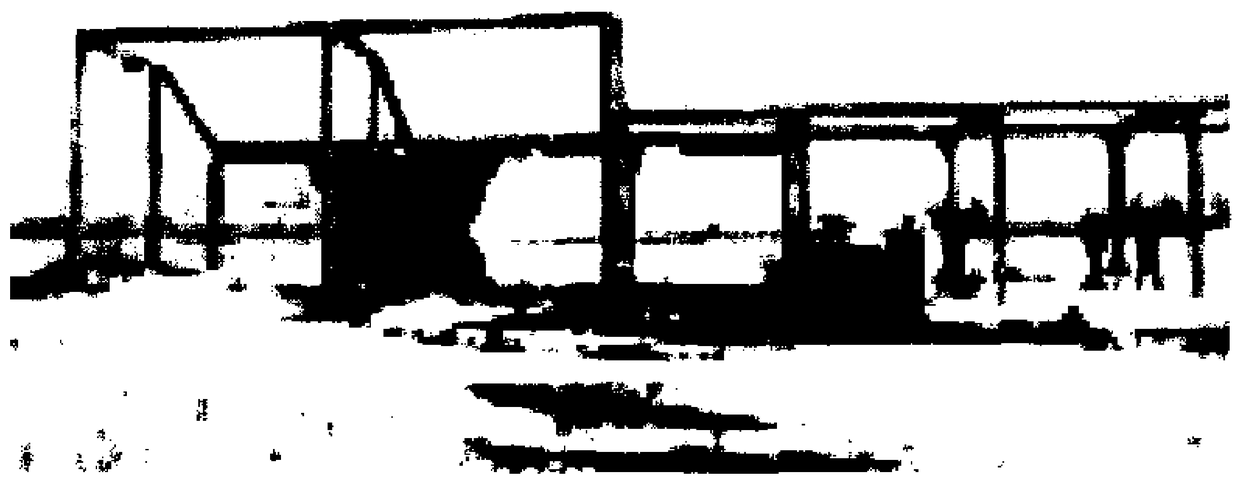
Map showing the location of the DU attack



Site Description

This is the site of a former military facility that includes garaging, administration and living quarters.

Figure 1



The surrounding area is of rough grass and scrub and there is evidence the area is used for grazing cattle. The nearest human habitation is about 150 metres away.

The buildings have suffered extensive damage and only the reinforced concrete skeleton remains complete. The walls are made up of hollow red terracotta bricks which are largely missing and the roof has been completely destroyed (Fig 1).

Radiation monitoring and soil sampling

The site was monitored and several areas of significantly increased activity found. Subsequent investigations resulted in the recovery of 3 DU penetrators and what appeared to be part of a sabot. These findings are described in detail below, together with a sketch map showing the general layout of the site.

Figure 2

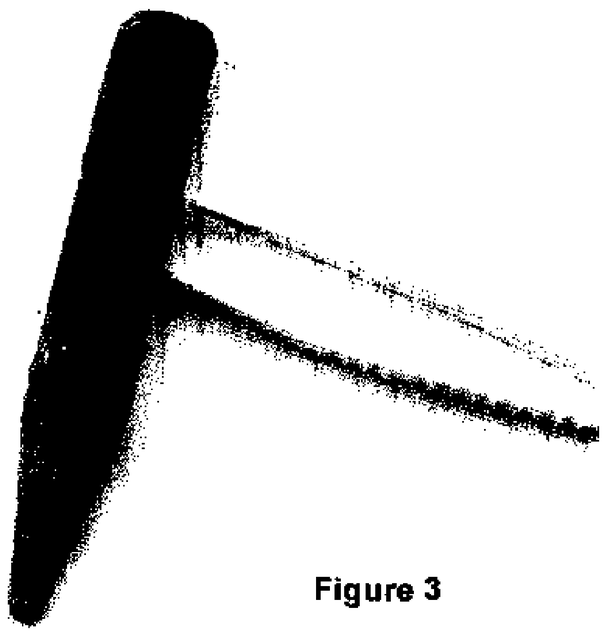
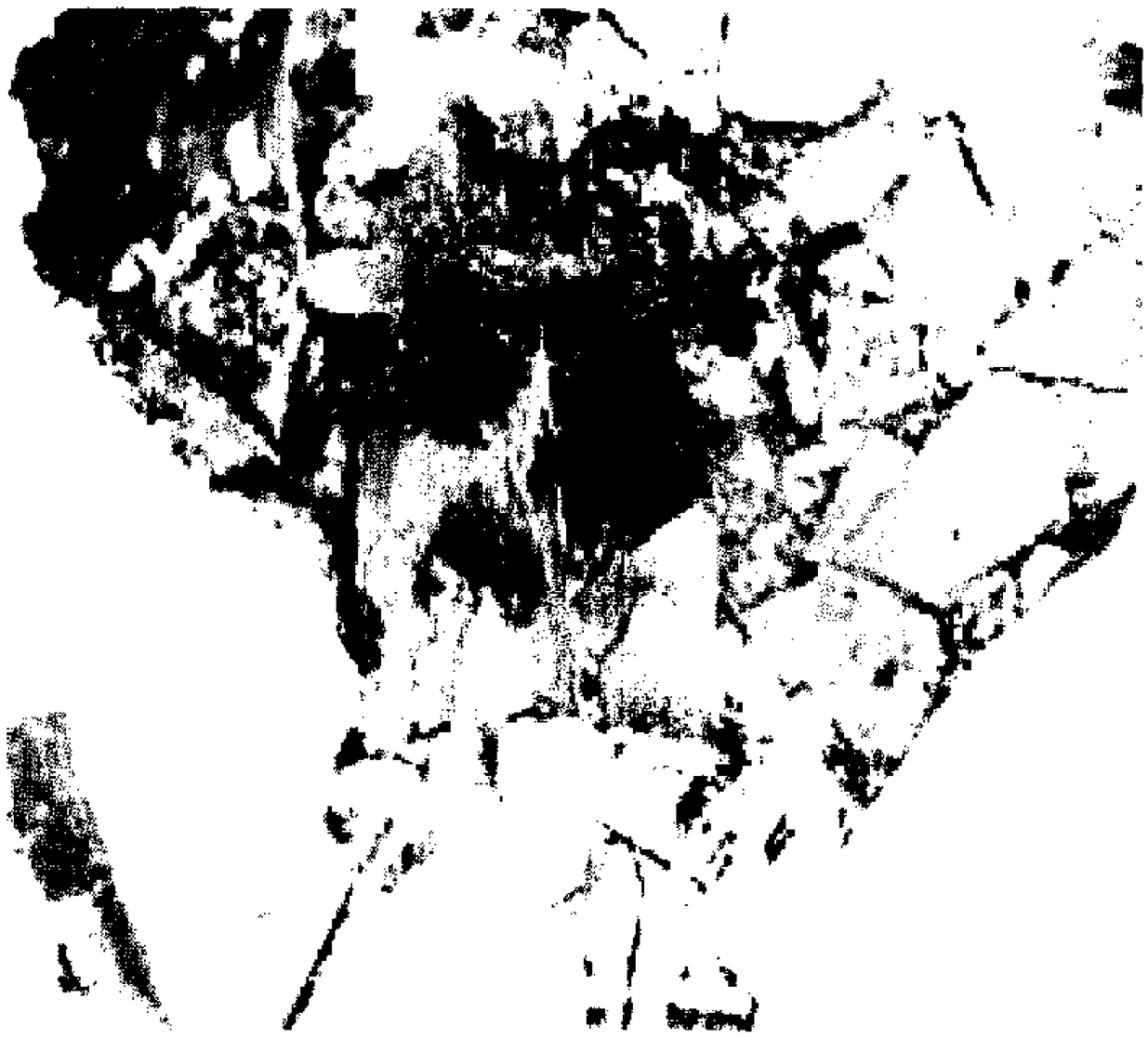


Figure 3

The south-facing wall of the garage block shows extensive damage (Fig 2) and it was in the outside face of this wall that a sabot and one DU penetrator (Fig 3) were recovered about 2 metres above ground level and in a hole in the brickwork. The sabot and penetrator were lodged in the cavity within a terracotta brick.

A second penetrator was found near ground level and embedded in a reinforced concrete slab (Fig 4). The concrete was heavily damaged at the point of impact and the back two thirds of the penetrator was exposed. The penetrator was dug out and the front end found to be lodged between two reinforcing bars. The tip of the penetrator broke off during the course of extraction and was recovered separately. Samples of the concrete dust and fragments were retained for analysis.

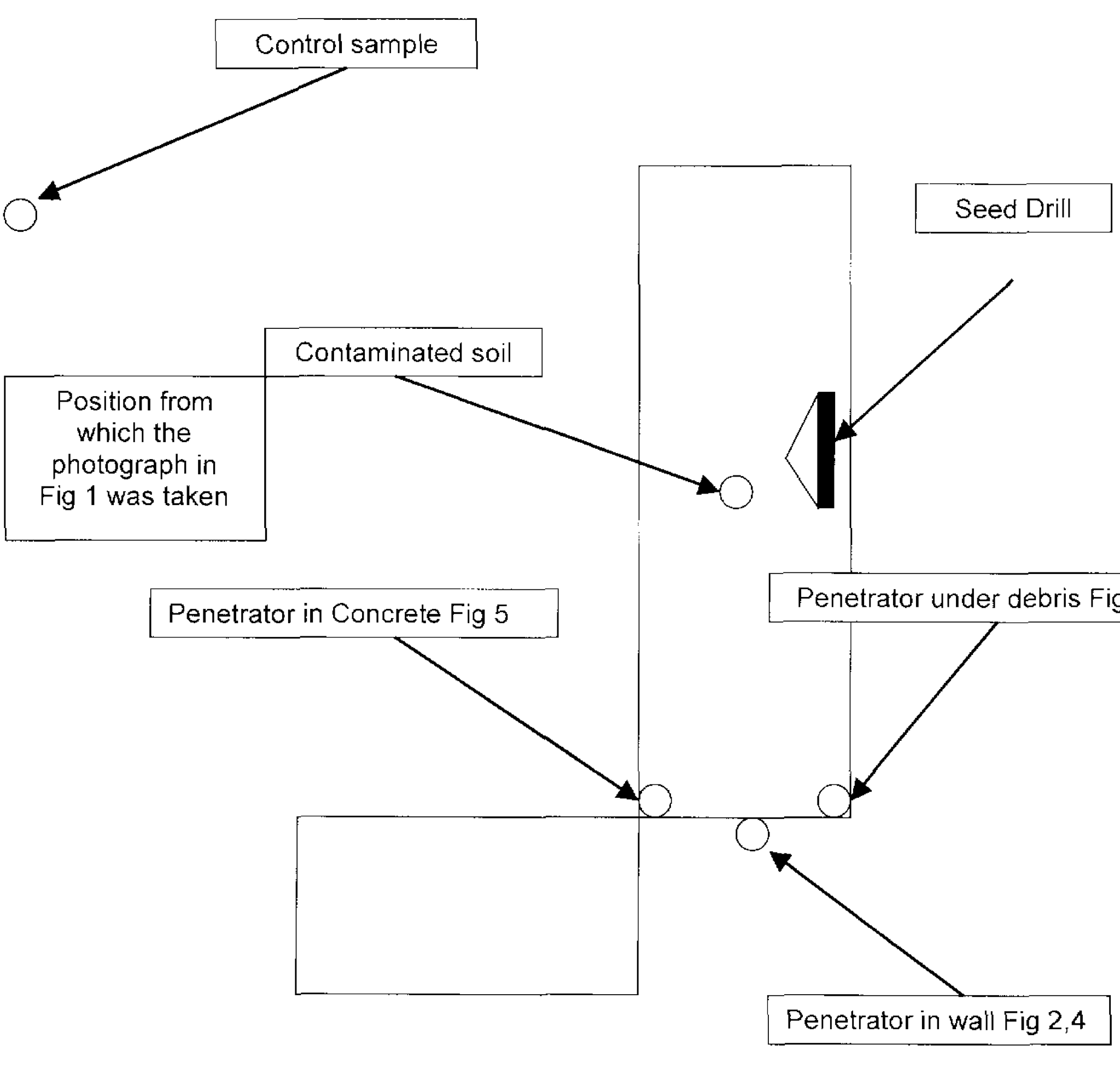
An area of increased activity was found beside a damaged seed drill. Some soil was excavated and the count rate increased. A soil sample was retained for analysis, but no penetrator or DU fragments were recovered. Another sample of soil was taken well away from the building as a "control" sample



A third penetrator was found on the soil surface under a layer of debris (Fig 5). The penetrator showed signs of bright yellow oxidation and soil samples were collected for further analysis.

During the survey it was noted that parts of the interior of the damaged building were covered with what appeared to be fragments of cement asbestos roofing and a sample was taken for further analysis.

Sketch map showing the location of recovered rounds and sample locations



Radiation monitoring results

Assumed background on track 50 metres away from building:	80nSv/h
Inside damaged building:	120nSv/h
Close to bullet hole in seed drill:	80nSv/h
By penetrator recovered from brick wall:	2μSv/h
Gross count rate from Exploranium:	1600 cps
Count rate from Mini Instruments Type 900 with 44B probe:	300 cps
By penetrator embedded in concrete:	4μSv/h
15cm away:	400nSv/h
30cm away:	150nSv/h

A just perceptible increase in reading led to the discovery of a penetrator buried under about 20cm of debris.

By damaged seed drill – diffuse source:	160 – 200nSv/h

Diffuse source – doserate dependent on position

Soil sample identity numbers

1B061001 – 1A	Debris from brick wall
1B061002 – 1B	Debris from brick wall
1B061003 – 2	Concrete beam
1B061004 – 3A	Debris above corroded penetrator
1B061005 – 3B	Soil around corroded penetrator
1B061006 – 4A	Soil from area of elevated activity by seed drill – top 10cm
1B061007 – 4B	Soil from area of elevated activity by seed drill – 10 to 20cm
1B061008 – 5A	Assumed background – top 5cm
1B061009 – 5B	Assumed background – 5 to 15cm

Annex F

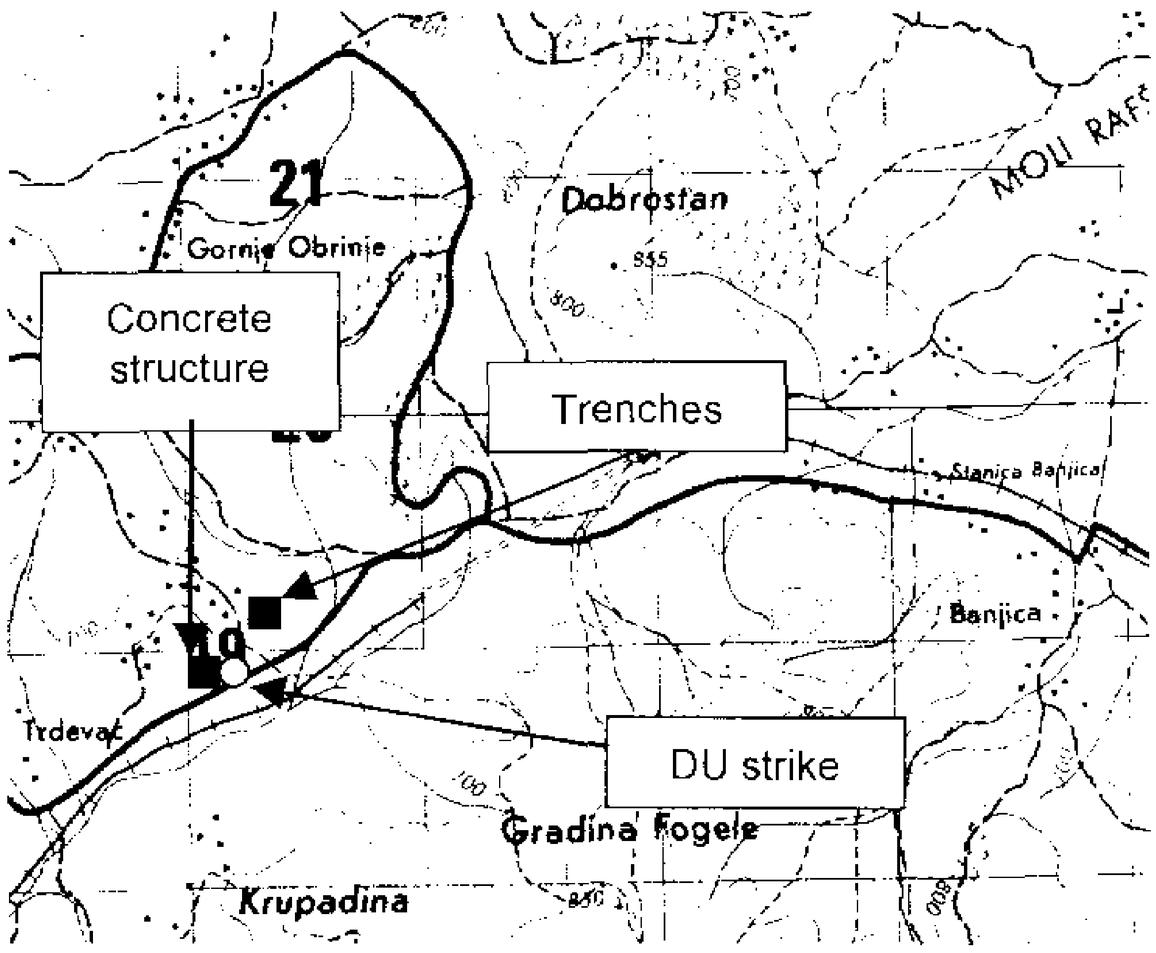
Site Visited - Site near Glogovac

Details of Attack

Mission Number	Date	Rounds Fired	Number of DU Rounds	Grid Reference	Target	Result
4260F	8 April 99			34T DN 834190	APC	Yes

APC = Armoured Personnel Carrier

Map showing the location of the DU attack



Site Description

The site overlooks a road and railway line (Fig 1) and is given over to rough pasture and scrub woodland. Where the road runs alongside the railway line there is a concrete structure (Fig 2) near the road that may have had a military purpose.

Figure 2

Radiation measurements

All readings were in range between 100 and 120nSv/h. No significantly enhanced readings were found anywhere.

Soil samples

A soil sample was taken about 5 metres from the concrete structure.

A second soil sample was collected about 300 metres north along the valley and on the hillside where there are a series of trenches and earthworks (Fig 3).

Soil sample identity numbers

1C061019 – T1. Near bunker?.
1C061020 – T2. On hillside.

Figure 3

Annex G

Site Visited - Farm and fields

Details of Attack

Mission Number	Date	Rounds Fired	Number of DU rounds	Grid Reference	Target	Result
2401F	7 June 99	370	231	34T DN 886168	Artillery	Yes

Map showing the location of the DU attack

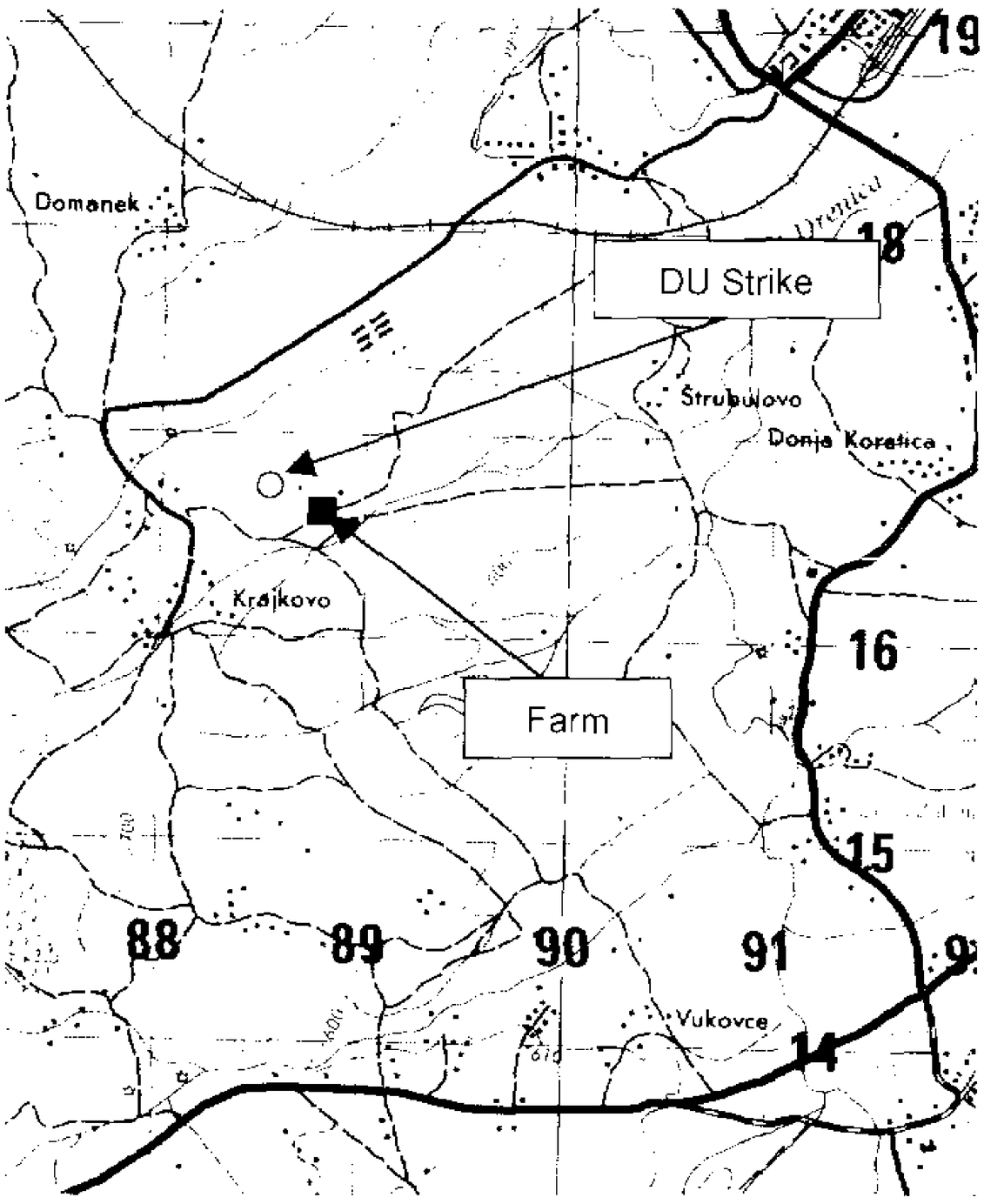


Figure 1

Site Description

The grid reference indicated a position in the middle of a field (Fig 1) but there was a farmhouse (Fig 2) about 400 metres away which was also visited. Within 20 metres of the farm buildings were the remains of an anti-aircraft gun.

Figure 2

The site is open farmland with ploughed fields and a few hedges. The soil was very moist clay. Based on local advice, the farmer probably grows his own food and obtains his water from a well, borehole or rainwater.

Radiation measurements

All readings were in the range between 100 and 120nSv/h and no enhanced readings were found anywhere.

Soil samples

A soil sample was taken in the field at the grid reference and another from the location where the anti-aircraft gun appears to have been mounted.

Soil sample identity numbers

1C061021 – K1. Grid reference.
1C061022 – K2. By gun position.

Annex H

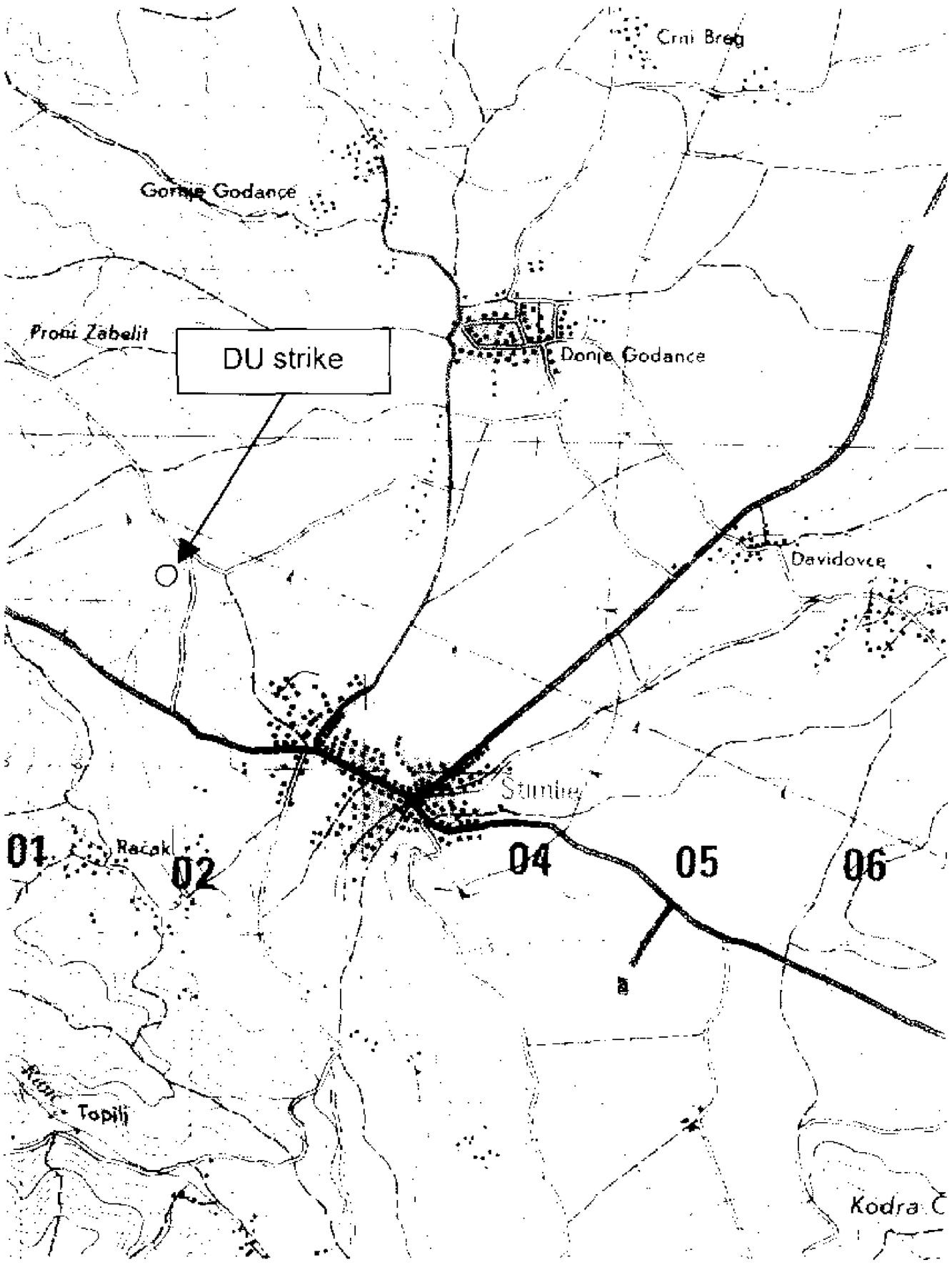
Site Visited - Pine Wood near Stimlje

Details of Attack

Mission Number	Date	Rounds Fired	Number of DU rounds	Grid Reference	Target	Result
3102F	11 May 99	150	94	34T EM 019990	APC	Miss

APC = Armoured Personnel Carrier

Map showing the location of the DU attack



Site Description

This site was just inside the edge of a pine wood (Fig 1) where there was obvious evidence of military occupation with trenches and earthworks. Damage to the trees suggested an attack by air burst weapons and remnants of cluster bombs were present. There were the remains of signs and tapes indicating that parts of the area had been mined.

Figure 1

Figure 2

No signs of DU ammunition were discovered, but monitoring was very difficult due to the risk from unexploded ordnance and mines. The pink circles on the ground (Fig 2) indicate the presence of metal that could be shrapnel, mines or possibly DU buried at depths at which the emitted radiation was completely attenuated by the soil.

Radiation measurements

All readings were in range between 100 and 120nSv/h and no enhanced readings were found anywhere.

Soil samples

A soil sample was collected by an earthwork about 25 metres into the wood.

Soil sample identity number

1C061023 – ST1. Forest.

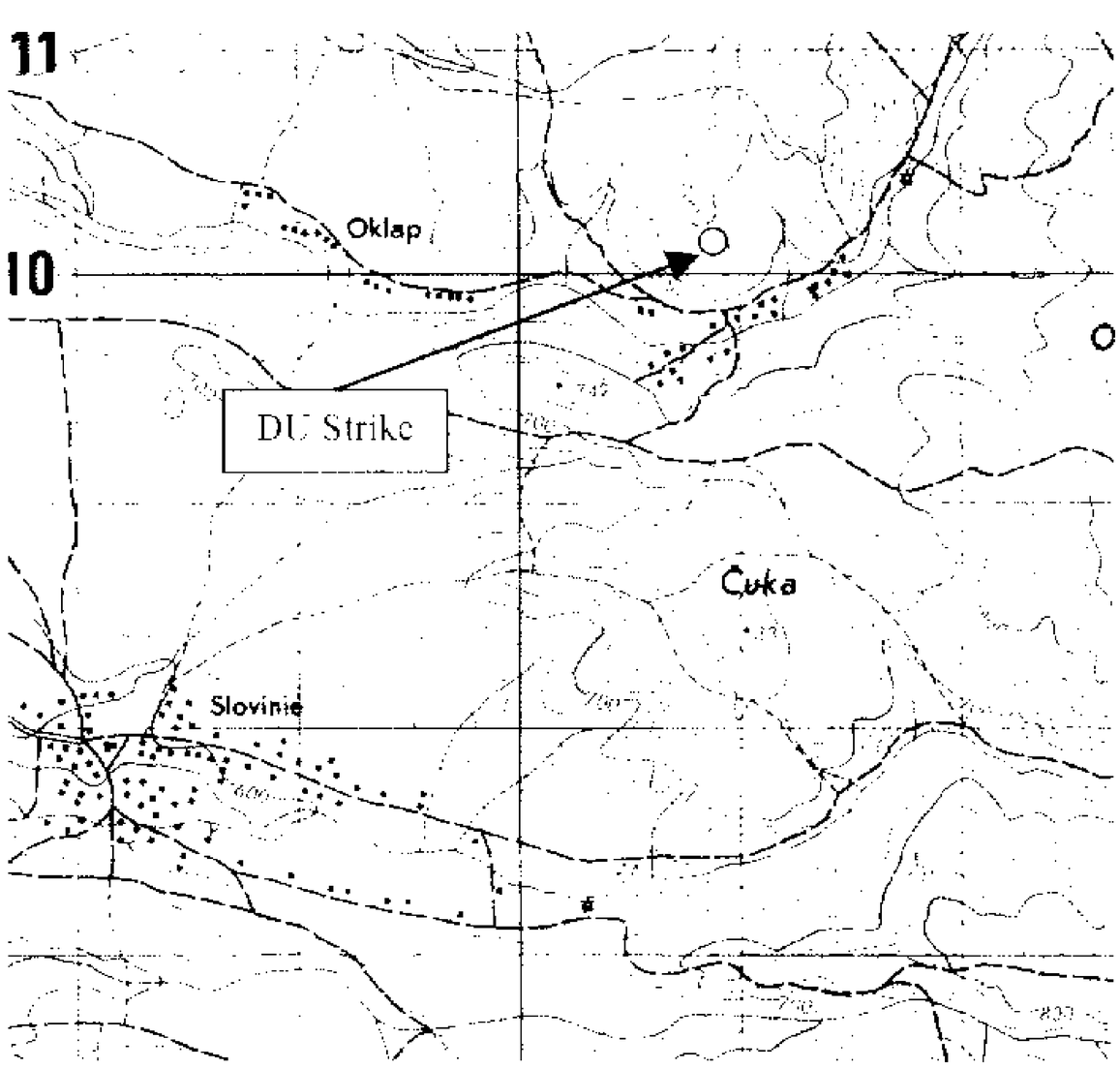
Annex I

Site Visited - Hill Top

Details of Attack

Mission Number	Date	Rounds Fired	Number of DU rounds	Grid Reference	Target	Result
3371F	22 May 99			34T EN 209103	Artillery	Yes

Map showing the location of the DU attack



Site Description

The site was reached after a steep climb up a hillside (Fig 1). An EOD team ensured the ground was clear of mines and unexploded ordnance. The pink paint on the ground (Fig 1) indicates the path cleared by the EOD team.

The soil was shallow and the underlying rock exposed in a number of places, particularly in gullies eroded in the hillside. The top of the hill was covered in oak scrub, which appeared to be cut regularly by the local inhabitants. Because of the scrub, visibility is restricted and it was not possible to find any evidence of military occupation or combat on the hill top.

Figure 1

Radiation measurements

All readings were in the range between 100 and 120nSv/h and no enhanced readings were found anywhere. One soil sample was collected (Fig 2) from what was judged to be a representative area.

Soil sample identity number

1C061018 – H1. Soil and shale.

Figure 2

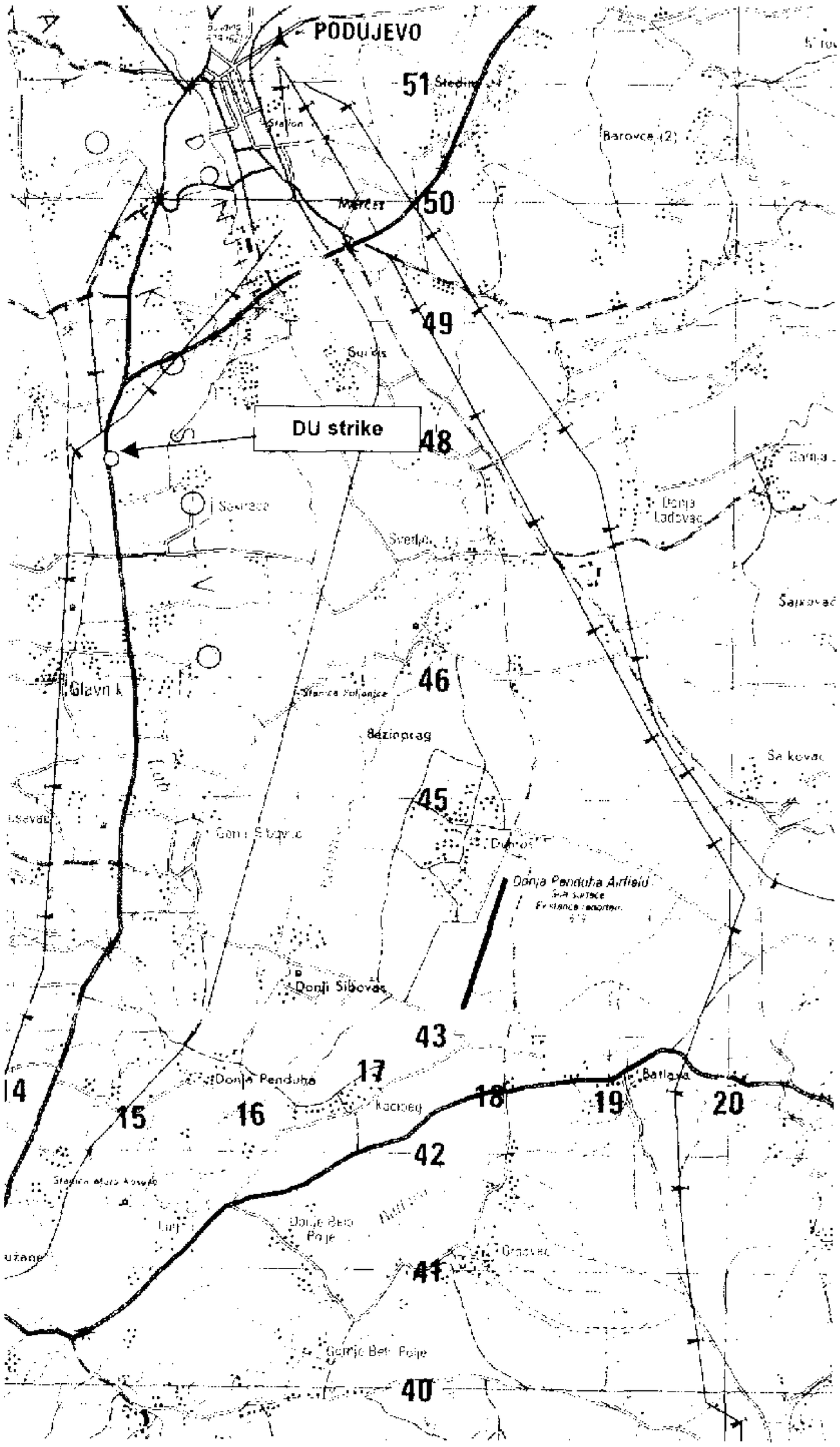
Annex J

Site Visited – Route Snake between Podujevo and Glavnik

Details of Attack

Mission Number	Date	Rounds Fired	Number of DU Rounds	Grid Reference	Target	Result
1503FA	10 May 99	200	125	34T EN148478	Vehicle	Hit

Map showing the location of the DU attack



Site Description

This site is by a road south of Podujevo. The area is extensively farmed with the fields used for growing crops and the soil contains clay and is fairly moist. The attack appears to have been made along the road which has been resurfaced since the attack. Building work has started east of the road and the fields are ploughed. To the west there is rough grazing. There is a house about 200 metres from the sample point.

The only obvious sign of combat was on the west side by a track leading off to some houses. There were some cartridge cases from small arms, parts of what appeared to be a uniform and evidence of burning in what had at one time been a hedge.

Radiation measurements

In-fill area off road towards new house: 80nSv/h
Ploughed field: 100 – 120nSv/h
By farm track on left hand side: 100nSv/h
Right hand side of track – 10 m away: 100nSv/h
Burnt area of land: 200nSv/h
Burnt area of land while digging down to sample: 300nSv/h

All other readings were in range between 100 and 120nSv/h – ie no enhanced readings were detected.

The presence of Cs^{137} was suggested by gamma spectrometry carried out with the Exploranium. This is not a material that would be associated with DU munitions. The material did not present an immediate threat to safety, but was considered to require further investigation.

Soil samples

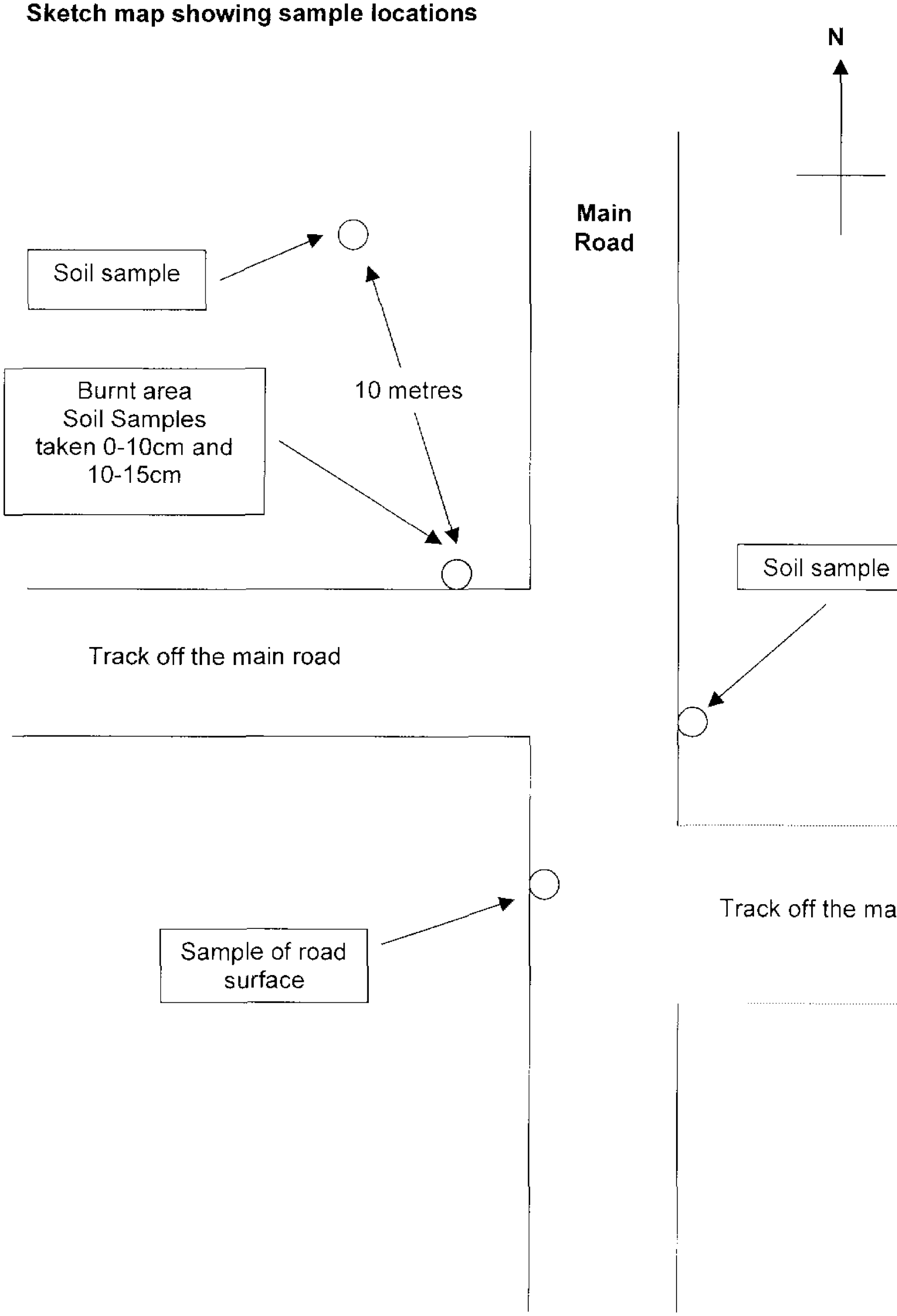
As shown on the attached sketch map, samples were collected from the burnt area (Fig 1), the surface of the road and from both sides of the road.

Figure 1

Soil sample identity numbers

1B061013 – G1 Tarmac
1B061014 – G2 Ploughed Field
1C061015 – G3 Burnt area - top 10cm
1C061016 – G4 Burnt area - 10 to 15cm
1C061017 – G5 Possible background sample

Sketch map showing sample locations



Annex K

Army Environmental Health Team Findings

Introduction

During the reconnaissance visit, Army Environmental Health Technicians and Officers considered the areas where enhancements could usefully be made to the existing environmental monitoring programme. The following observations and recommendations were made by OC EMT assisted by Medical Branch HQ MNB.

Air quality

Four camps were identified as requiring further investigation into air quality:

a. St Iligius Lines. This camp is near Kosovo A and B power plants in Obilic that have been the source of air quality concerns for some time. The impact of the co-located mine- equipment repair facility requires investigation.

b. Paveway Lines. This camp is approximately 4km from the open cast lignite mine near Obilic. Several areas of this mine are alight, generating significant amounts of smoke.

c. Murphy Lines. This camp is located adjacent to a shock absorber factory and an industrial switchboard / metal container factory.

d. Harden Lines. Immediately adjacent to the camp is an asphalt works. This only operates intermittently and although no complaints have been received there is the potential for a dust problem.

Asbestos

Asbestos was used extensively as a building material throughout the Federal Republic of Yugoslavia and is a potential hazard where troops are operating around derelict and damaged buildings. An asbestos register of all camps accommodating UK personnel should be collated and a suitable risk assessment carried out. Asbestos contamination has been positively identified at the former Yugoslavian

Army barracks where the DU penetrators were recovered

Water quality

Currently, bottled water is the only potable source of drinking water for BRITFOR personnel in Kosovo. Water for ablutions is provided either by municipal supply or borehole, some of which use Pre-mac treatment sets (see table below).

Water Source	Number of Locations	Number with Pre-mac Treatment
Borehole	9	7
Municipal Supply	9	3

A chemical water sampling programme has recently been initiated by HQ MNB(C) EHT. This is to determine the quality of water passing through Pre-mac treatment sets with a view to providing drinking water. The protocol is that after three acceptable samples a recommendation will be made to allow its use as a potable supply. This should remain the main effort, however, a chemical analysis of those supplies that do not undergo further (Pre-mac) treatment is required (2 x borehole and 6 x municipal). In the long term, analysis of the quality of borehole water, prior to treatment is requested.

Soil sampling

The impact of land contamination on UK personnel is not thought to be significant. 11 of the camps are classed as Temporary Field Accommodation (TFA) sites. Most of these are built upon layers of hardcore and concrete, with the topsoil often having been removed. If soil analysis is required, then samples may be taken from around the perimeter of the camps.

Future work

Further environmental and industrial hazard (EIH) intelligence (if possible) is required for the following:

a. Chemicals used in the shock absorber and switchboard factories adjacent to Murphy Lines.

b. The condition of the reported corroding chlorine containers at the water board site approximately 1km from Slim Lines in Pristina.

c. The use of an occasionally working, municipal heating system approximately 1km from Slim Lines

d. The contents of two large silos approximately 800m from Gundolph Lines near Pristina.

Annex L

Photographs and Descriptions of the DU Rounds Recovered

All rounds were recovered at the former Yugoslavian Army barracks. The details of the attack at this site are as follows:

Mission Number	Date	Rounds fired	Number of DU rounds	Grid Reference	Target	Result
2467F	11 May 99	700	438	34T EN 187470	Building	Hit

Round recovered from the wall

Sample 1

1 cm

This penetrator was found lying together with the sabot in the cavity of a brick wall about 2 metres above the ground. The penetrator and sabot appear to be intact. There is also what appears to be a small amount of yellow surface oxidation present on the penetrator.

Sabot

Round recovered from the reinforced concrete slab

Sample 2

1 cm

This penetrator was extracted from a reinforced concrete slab. The front half of the penetrator was lodged in the concrete and the rear half was exposed. The front of the penetrator appears to have reacted with the concrete. The tip of the penetrator broke off whilst the penetrator was being extracted. Fragments of what appeared to be the aluminium windshield were also recovered.

Sabot Fragments

Round recovered from the soil surface from under 20cm of debris

This penetrator was found on the soil surface under rubble and snow. This was the most severely corroded penetrator found. The yellow oxide was very loose and readily broke away from the penetrator as can be seen in these photographs.

Sample 3 – End view

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Job Number: 61/01

ADMINISTRATION

Customer Name:	D Smith	Customer Address:	DRPS
Date of Issue:			
Date of Receipt:	2/1/1	Date of Testing:	2/1/1

ANALYSIS AND REPORTING

Analysis Type and Technical Comments: The sample has been analysed by Gamma Spectrometry.

Date Reported:	5/2/1	Reporter:	M Simpson	Signature:	Original signed
Date Countersigned:		Countersigner:		Signature:	

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Sample Analysis Reference No.	Customer's Reference	^{40}K	^{134}Cs	^{137}Cs	^{234}Th	^{234}U	^{235}U	^{238}U	^{234}Pa	^{234M}Pa	
		Reporting Units Bqkg^{-1}									
1B061001	1A	737±64	⩾0.4	⩾1	602±148	⩾1121	⩾8	⩾1742	⩾3	1474±388	VJ Barracks debris from wall
1B061002	1B	556±51	⩾0.4	⩾1	228±61	⩾837	⩾5	⩾1267	⩾3	481±201	VJ Barracks ditto
1B061003	2	480±72	⩾2	⩾2	36686±8691	⩾6351	681±90	52477±26290	102±50	90230+16150	VJ Barracks concrete debris
1B061004	3A	343±32	1.1±0.6	72+5	1816±433	⩾1100	38±9	⩾2075	28±14	4456±848	VJ Barracks debris on top of soil nr penetrator
1B061005	3B	411±37	⩾1	119±9	10271±2434	⩾2239	174+24	⩾4387	44+22	21066±3778	VJ Barracks soil from around penetrator
1B061006	4A	306−29	6±1	1241±83	⩾16	⩾1477	⩾9	⩾1567	⩾2	382±220	VJ Barracks soil from contam. area –top 100mm
1B061007	4B	350±34	3+1	533±36	⩾14	⩾719	⩾7	⩾1370	⩾2	⩾69	VJ Barracks soil from contam. area –next 100mm
1B061008	5A	275±31	2±1	328±23	⩾13	⩾763	⩾7	⩾1268	⩾4	⩾62	VJ Barracks reference sample –top 50 mm
1B061009	5B	436±39	⩾0.3	82+6	⩾11	⩾549	⩾5	⩾999	⩾3	⩾68	VJ Barracks reference sample - 50-150 mm
1B061010	W1	328+30	⩾0.4	106±8	⩾14	⩾1005	⩾6	⩾1279	⩾2	⩾72	Waterloo Lines under side concrete slab
1B061011	W2	329±31	0.9+0.5	68±5	40+24	⩾852	⩾5	⩾1189	⩾2	⩾67	Waterloo Lines outside fence – removed soil
1B061012	W3	267±28	⩾0.3	121±9	⩾12	⩾750	⩾5	⩾1183	⩾1	⩾59	Waterloo Lines outside fence – removed vegetation
1B061013	G1	615±55	⩾0.4	⩾1	⩾14	⩾844	⩾6	⩾1231	⩾4	⩾94	North Glavnick - tarmac
1B061014	G2	274+28	2±1	446±30	⩾12	⩾736	⩾6	⩾1127	⩾2	⩾53	North Glavnick – ploughed field
1C061015	G3	290±29	5±1	927±61	⩾29	⩾1987	⩾4	⩾6532	⩾2	⩾48	North Glavnick – burnt area –top 100 mm
1C061016	G4	317±28	5±1	1081±71	⩾26	⩾2021	⩾4	⩾6152	⩾2	⩾42	North Glavnick – burnt area – 100-150 mm
Sample Analysis Reference No.	Customer's Reference	^{40}K	^{134}Cs	^{137}Cs	^{234}Th	^{234}U	^{235}U	^{238}U	^{234}Pa	^{234M}Pa	

Analysed by: Date:

Countersigned by: Date:

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Sample Analysis Reference No.	Customer's Reference	^{40}K	^{134}Cs	^{137}Cs	^{234}Th	^{234}U	^{235}U	^{238}U	^{234}Pa	^{234M}Pa	
		Reporting Units Bqkg^{-1}									
1C061017	G5	325±33	⩾03	155±11	⩾20	⩾1362	⩾3	⩾3910	⩾1	⩾45	North Glavnick – background sample
1C061018	H1	504±43	⩾0.3	2±1	⩾19	⩾1246	⩾2	⩾3577	⩾1	225±140	Hill Top – soil & shale
1C061019	T1	706±56	⩾0.3	27±2	⩾16	⩾1077	⩾2	⩾3490	⩾1	⩾46	Site near Glogovac – near dug-out shelter
1C061020	T2	605±49	⩾0.3	39±3	⩾22	⩾1449	⩾3	⩾4435	⩾1	⩾59	Site near Glogocav - background
1C061021	K1	161±20	⩾0.3	19±2	⩾20	⩾1234	⩾3	⩾4054	⩾1	⩾55	Reputed position of artillery
1C061022	K2	181±22	⩾0.3	21±2	⩾20	⩾1338	⩾3	⩾4196	⩾1	270±154	Soil adjacent to Serb gun wreckage
1C061023	ST1	222±24	⩾0.3	23±2	⩾17	⩾1059	⩾2	⩾3618	⩾1	⩾44	Stimlje forest – dug-in position
1C061024	Fly Ash	95±20	⩾0.3	⩾0.3	⩾19	⩾1061	⩾2	⩾3526	⩾1	⩾50	Fly ash
1C061025	Unknown	252±26	⩾0.2	11±1	⩾15	⩾1032	⩾2	⩾3017	⩾1	⩾41	Slim Lines soil sample
Sample Analysis Reference No.	Customer's Reference	^{40}K	^{134}Cs	^{137}Cs	^{234}Th	^{234}U	^{235}U	^{238}U	^{234}Pa	^{234M}Pa	

Analysed by: Date:

Countersigned by: Date:

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Job Number: 71/01

ADMINISTRATION

Customer Name:	D Smith	Customer Address:	DRPS for 2PUS
Date of Issue:	27/3/01		
Date of Receipt:	Feb 2001	Date of Testing:	Feb 2001

ANALYSIS AND REPORTING

Analysis Type and Technical Comments:	The samples were analysed by alpha spectrometry.

Date Reported:	27/3/01	Reporter:	A Bushell	Signature:	Original signed
Date Countersigned:	27/03/01	Countersigner:	M Simpson	Signature:	Original signed

The reported uncertainty is calculated from both the counting and preparation. The confidence level is 95% (k factor or 1.96). The certificate is issued in accordance with the requirements of the United Kingdom Accreditation Service as specified in the UKAS Accredited Standard and UKAS regulations. It provides traceability of measurement to recognised national standards and to the units realised by the National Physical Laboratory or other recognised National Standards Laboratory.

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Job Number: 71/01

URANIUM ISOTOPIC ACTIVITY

Customer Reference	Spectrum Number	Estimated sample activity ($Bq.kg^{-1}$ dry sample) ^{238}U	^{235}U	^{234}U	TOTAL	Ratio U238/U234	
1A	1O071021.U	4681.6 ± 532.8	51.2 ± 9.2	551.2 ± 66.5	5284.0 ± 537.0	8.5 + 1.4	
1B	1O071022.U	2195.6 ± 285.2	25.1 ± 6.3	290.1 ± 41.5	2510.9 ± 288.2	7.6 ± 1.5	
2	1O071023.U	20626 + 9740.1	255.5 ± 136.4	2835.6 ± 1353.6	23717.1 ± 9834.6	7.3 ± 4.9	
5A	1P071011.U	14.9 + 1.6	0.3 ± 0.2	15.2 ± 1.7	30.4 ± 2.4	1.0 ± 0.2	
5B	1P071012.U	20.7 ± 2.2	0.6 ± 0.3	19.4 ± 2.1	40.6 + 3.1	1.1 ± 0.2	
W1	1P071013.U	14.1 ± 1.6	0.5 ± 0.2	12.0 ± 1.4	26.6 ± 2.1	1.2 ± 0.2	
W2	1P071014.U	14.5 ± 1.7	0.6 ± 0.3	13.6 + 1.6	28.7 ± 2.3	1.1 + 0.2	
W3	1P071015.U	16.2 ± 2.7	< 0.3	15.9 + 2.6	32.4 ± 3.8	1.0 ± 0.2	
G1	1P071016.U	20.8 ± 2.4	0.7 + 0.3	20.6 ± 2.4	42.1 ± 3.4	1.0 + 0.2	
G2	1P071017.U	9.3 ± 1.2	< 0.3	11.5 + 1.4	21.1 + 1.9	0.8 + 0.1	
G3	1P071017.U	10.8 ± 1.4	< 0.3	13.2 ± 1.6	24.4 ± 2.1	0.8 ± 0.1	
G4	1P071018.U	12.7 ± 1.6	< 0.3	14.7 ± 1.7	27.7 ± 2.3	0.9 ± 0.1	
G5	1P071019.U	13.4 ± 1.6	< 0.3	13.6 ± 1.6	27.3 ± 2.3	1.0 ± 0.2	

Reported by: A Bushell — Date: 27/3/01

Countersigned by: M Simpson — Date:27/03/01

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Job Number: 71/01

URANIUM ISOTOPIC ACTIVITY

Customer Reference	Spectrum Number	Estimated sample activity ($Bq.kg^{-1}$ dry sample) ^{238}U	^{235}U	^{234}U	TOTAL	Ratio U238/U234
H1	1P0711003.U	20.6 ± 2.1	0.5 ± 0.2	13.9 ± 1.6	35.0 ± 2.6	1.5 ± 0.2
T1	1P071004.U	17.6 ± 2.5	0.7 ± 0.4	15.3 ± 2.3	33.6 + 3.4	1.1 ± 0.2
T2	1P071005.U	28.5 ± 2.7	0.5 ± 0.2	16.7 ± 1.8	45.6 + 3.2	1.7 ± 0.2
K1	1P071006.U	23.5 ± 2.4	0.5 ± 0.3	24.0 ± 2.5	48.1 + 3.5	1.0 ± 0.1
K2	1P071007.U	19.2 + 1.9	0.5 + 0.2	18.0 + 1.8	37.7 + 2.7	1.1 ± 0.2
ST1	1P071008.U	15.4 + 1.7	0.5 + 0.3	18.0 + 1.9	33.9 + 2.6	0.9 ± 0.1
flyash	1P071009.U	26.5 + 2.7	0.9 + 0.3	21.9 + 2.3	49.3 ± 3.6	1.2 ± 0.2

Reported by: A Bushell — Date: 27/3/01

Countersigned by: M Simpson — Date:27/03/01