

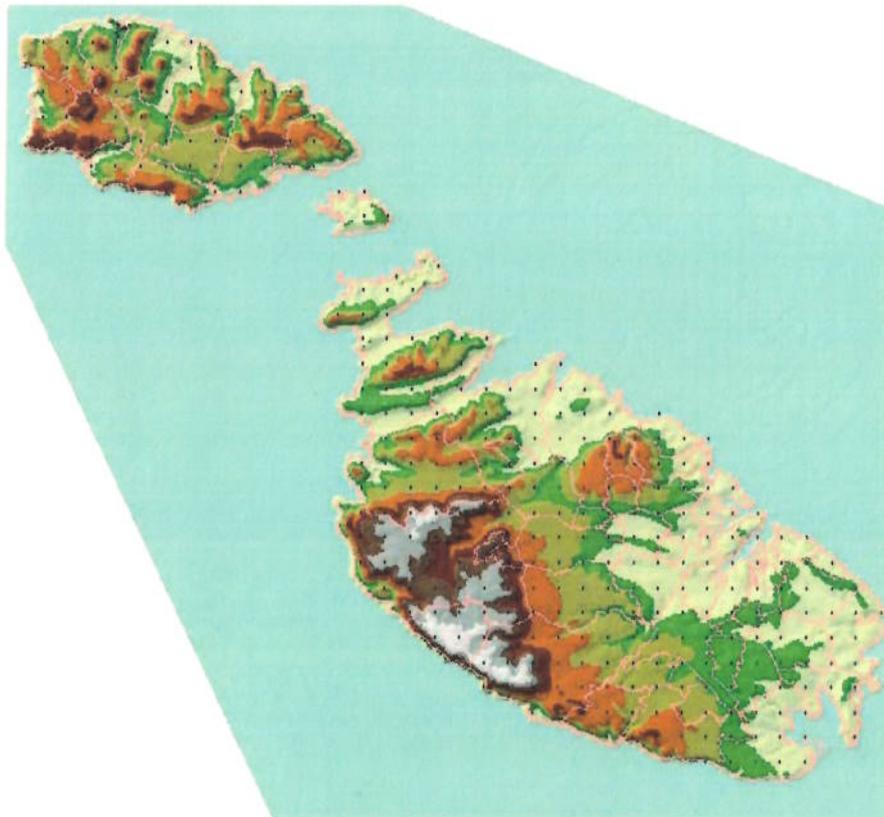
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MALTA

**Ministry of Agriculture & Fisheries
Malta**



**MALSIS, A SOIL INFORMATION SYSTEM
FOR THE MALTESE ISLANDS
LIFE 00/TCY/MT/000036
PHASE I PROGRESS REPORT
01st March – 31st August 2002**



**A report submitted to the EU LIFE Commission
30th September 2002**

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1. BACKGROUND

The overall objectives of the MALSIS project, A Soil Information System for the Maltese Islands, are:

- To create digital soil property maps of Malta,
- To undertake laboratory analysis of soil samples
- To construct a soil information system.
- To permit Malta, as an EU accession country, to address environmental legislation affecting groundwater contamination by nitrates (80/778/EEC, 91/676/EEC), leading to the production of a code of good agricultural practice and a nitrate action plan.
- To facilitate harmonisation with the European Soil Information System (EUSIS).

The 2-year project started in March 2002¹. Since then a range of activities have taken place both in Malta and in the UK. This report presents progress for the MALSIS project for the six months from March 2002 to August 2002. For each project component, the report details the project objectives, the actions taken and products/deliverables. Finally the anticipated forward work plan for the next immediate period is outlined.

2. OBJECTIVES

2.1. Field Survey Objectives

The objectives of the field survey component were the following:

1. To devise, test and subsequently refine a protocol for fieldwork.
2. To devise, test and subsequently refine a field recording form for fieldwork.
3. To undertake a reconnaissance soil survey of Malta and Gozo in order to identify the main soil landscapes and to make a judgement on the range and variability of soils within each of these landscapes.
4. To review the validity of existing soil maps.
5. To produce a preliminary flowchart methodology for the soil classification of soils on Malta, Gozo and Comino.
6. To visit as many soil landscapes as possible and to observe as wide a range of soil types in each landscape as possible in order to assess the spatial variability of soils in the landscapes whilst testing and refining the protocols.
7. To train the Maltese national team in field survey and classification techniques, both in the UK and in Malta.
8. To initiate the main grid survey and, with the directed input of the Maltese project field staff, to test the soil description and sampling protocols that would have been developed.

¹ Note: the project start date was altered with the consent of the EU LIFE office to March 2002 due to contractual delays before the project formally started.

2.2. Soil Laboratory Objectives

The objectives of the laboratory analysis component were the following:

1. To train the Maltese national team in good soil laboratory practice in the UK.
2. To carry out a review of the Maltese soil laboratory (Agricultural Chemistry Laboratory) and to assess the current practice of receiving and processing samples from the field survey.
3. To strengthen laboratory management and good laboratory practice in the Agricultural Chemistry Laboratory by recommending changes to the documentation, standard operating procedures and validation techniques.

2.3. Information Systems Objectives

The objectives of the information systems component were the following:

1. To train the Maltese national team in GIS and database techniques in the UK.
2. To draw up a provisional system design for the overall soils information system, as it will integrate within existing laboratory systems.
3. To draw up a provisional database structure design for the field recording form.
4. To specify and procure the required information systems hardware and software.
5. To obtain access to suitable digital 'backdrop' data for the spatial element of the information system.

2.4. Project Direction and Strategy Objectives

The following strategic objectives were set:

1. To review and refine the project plan to ensure the timely and efficient management of the project.
2. To establish a provisional membership for a Soil Steering Committee for the project to ensure the sustainability of the Soils Office subsequent to the project.
3. To ensure that dissemination and publicity activities are undertaken to promote the project.
4. To identify key final output product requirements from the survey process.
5. To ensure the appropriate resources, facilities and infrastructure are made available in a timely fashion for the project.

3. ACTIVITIES AND DELIVERABLES

3.1. Field Survey Activities and Deliverables

3.1.1. Training

A group of five Maltese national team members attended a five day training programme at the National Soil Research Institute (NSRI), Cranfield University at Silsoe, UK, in Field Survey Techniques from Monday 13th to Friday 17th May 2002. The programme for this course is appended to the report (Appendix 1).

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The course contained an initial soil awareness session, introducing soil terminology, formation and morphology. The main elements of field description were explained based on the NSRI Soil Survey Field Handbook, and where necessary, with comparison to the FAO Guidelines for Soil Profile Description. Emphasis was placed on assessing soil texture and structure, the recording of colour, mottles and stones, and use of a data record card adapted for use in Malta. A practical session gave the participants an opportunity to develop these assessment skills based on a set of soil samples from the UK. Field experience was gained by trips to two farms with soils developed on limestone and chalk – pit digging, soil horizon differentiation, hand texturing and slope assessment were practised.

A further afternoon of tuition in soil classification was provided at Cranfield University at Silsoe, UK, on 10th July, 2002 for key members of the Maltese field survey team. The resultant scheme developed specifically for the classification of Maltese soils is described in Appendix 2.

Cranfield University staff undertook a series of further instruction sessions on soil survey and classification in the field, as part of a mission to Malta from 26th May to 6th June.

3.1.2. Field Protocols

Location of sites

Three types of topological maps were identified:

- 1940's map on which historic land holding is shown (1:2500 scale) – only archive copies available.
- 1970's maps at 1:2500 printed on 2 km by 1 km sheets with 100 m grid lines and contoured at 2.5 m intervals (example attached as Appendix 3a).
- 1990's digital map at 1:2500 scale – printed on 2 km by 1 km sheets but with no contours printed and gridlines only shown at 200 m intervals i.e. 0.5 km centres are not shown (example attached as Appendix 3b).

In addition, a complete set of aerial photographs of Malta and Gozo were made available for use by the MALSIS team at no direct cost to the project. (Example attached as Appendix 3c).

Base maps are therefore available on 2 km by 1 km sheets making field location of grid intersects at 0000, 0000 difficult as either two or four sheets of paper are needed to find each grid point. The 1970's maps show field boundaries most accurately and have 2.5-m contours.

It was recommended by NSRI that the target points be displaced 500 m north and east of the 1 km intersect. It was then decided by the team to use the 1970's maps in the field and to locate the Inventory sites on 5000, 5000 centres in order that only one map is required in the field to identify each site. This is being achieved by using photocopies of the maps produced by Mr Anthony Borg.

Subsequent field experience showed that the 1970's maps are considerably out of date with respect to farm tracks and new developments. It was therefore proposed to print the up-to-date digital maps plus air photos for the trial transects in an attempt to improve the locational information provided for each site. Copies of the 1990's printed maps have been ordered in the expectation that these will have a better representation of urban land and roads/tracks in rural areas.

Global Positioning System (GPS)

It was originally planned to use a GPS for locating the sampling sites. However the unit used gave readings in latitude and longitude rather than metres which made locating target points defined in metres impossible. It is possible to calibrate GPS receivers in metres, but with the use of 1:2500 base maps for location combined with the large number of field boundaries and rural building for cross referencing, this was not considered essential. A decision was made to take digital photographs of each grid location in the four directions of the compass. For this reason a digital camera was procured. The photos will be included in the spatial database and will provide a means of identification of the site in future soil-monitoring programmes. An example is provided in Appendix 4.

Derivation and Refining of Field Protocols

A first draft of the field protocol was compiled in England based on NSRI experience with grid sampling in the England and Wales National Soil Inventory.

In the field in Malta, discussion and demonstration centred on:

- The order in which the various parameters should be described and samples taken to avoid disturbance and contamination. These discussions continued during the three-week training period and resulted in changes to the draft protocol document.
- The size and shape of the hole to avoid digging it too big (increases time spent at each site) but to allow removal of subsoil samples without contamination from the dry dusty topsoil.
- The revision of the flow chart for hand texturing to include FAO cut-offs of particle size classes.
- The techniques of topsoil sampling using screw and/gouge augers to achieve a sample size of 1.5 kg.
- The techniques of subsoil sampling to avoid contamination.
- The decision to take top and sub-soil horizon samples related to bulk density samples.
- The decision to use the Japanese version of the soil colour charts rather than the American Munsell charts, and to record both dry colour and rubbed, moist colour.
- The use of a field penetrometer to compare with bulk density data.
- The decision to archive the original field sheets and keep copies for input.

Subsoil sampling

The team experimented with gouge augers of different diameters. Following these trials, it was decided that in future the subsoil would NOT be sampled from the auger and 25 cores but from 50 to 65 cm depth in the pit. Firstly, it was proving physically hard to auger with the Dutch auger 25 times and then extract a sample with the screw auger without contamination from the dusty topsoil. Secondly, it was realised that in many sites the actual material being sampled at the 25 points would be likely to come from different parts of the profile and therefore lack meaning pedologically. Thirdly, it proved difficult to auger into soft limestone – taking c.1.5 hours to complete 25.



However, it was felt by NSRI staff that information on the local variability in profile depth from the 25 sample points would be very useful when attempting to assess local soil variability.

3.1.3. Field Recording Form

A first draft of the field recording form was compiled in England based on NSRI experience. As part of the first week's activities by the NSRI team on Malta, Mr Sharlo Camilleri presented the amendments he had made to the draft versions of recording form and list of parameters. These were to form the basis of on-going changes in content and format during the next three weeks. The aim was to finalise versions of all the documents on June 14th and send them to a printer.

The protocol for siting describing and archiving the results was presented on paper and a disk left of the current version. The final version is presented as Appendix 5.

3.1.4. Soil Classification and Soil Landscapes description

The only soil survey information available for the Maltese islands is the 1:31,680 scale map and accompanying report produced by Lang (1960) for the then Colonial Office. The map shows the distribution of 13 mapping units, 9 of which are designated as being characterised by a single 'soil series' and 4 of which are 'complexes' or 'sequences' in which a number of soil series occur in a complex and often unpredictable pattern. The map was based on detailed field observations within two areas comprising about 10 square miles in total. The remaining 112 square miles of the Islands were mapped from aerial photographs and occasional 'ground-truth' observations along traverses. The accompanying report describes the soil map units and their broad characteristics, gives a classification of the soil series and some analytical data on their phosphate, exchangeable bases, organic matter content, pH and CaCO₃ content and a set of qualitative descriptions of soil profiles. The soil series concept used by Lang (1960) was largely based on geological criteria, as was the case in many soil studies at that time. Individual soil series were defined to incorporate the wide range of soil depths and textural classes that could be found on individual geological parent materials.

Malta currently requires spatial information on its soil resources in the form of soil physical and chemical properties that can be used in existing European-wide interpretative environmental models. It is also necessary that any soil information should be compatible with current European classification systems. In the light of these needs the Lang (1960) map and report are unsatisfactory for the following reasons.

- Lang (1960) used the Kubiena (1953) soil classification system, which is very out of date and does not allow Maltese data to be placed in their current European or Global context.
- The methods used to sample and describe soil properties and to characterise the soil map units are inadequate to quantify the range of soil properties across the islands, or to understand the spatial variation of properties within map units.
- The range of properties analysed is focused on crop nutrients, organic matter and particle-size, plus data on exchangeable sodium and conductivity. There is however, no information on soil hydrology, heavy metals or trace elements.

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- The rapid expansion of urban areas since 1960 has markedly changed the Maltese landscape in and around these new urban areas, particularly where topsoil material from the development sites has been used to create new terraces or to augment and deepen existing ones.

As a precursor to the National 1 km grid survey a 3-week reconnaissance soil survey was undertaken between May 27th and June 14th 2002. The original aims of this exercise were to identify the chief soil landscapes and make best judgements on the range and variability of soils within each of these landscapes. This activity was linked to the launch of the grid survey by identifying four west east transects across the island, which provided the opportunity to investigate a broad cross-section of the soil types on Malta. These transects crossed the limestone/calcareous shale sequence from oldest to youngest rocks and also incorporated the deep colluvial soils found in some of the broad ancient valleys on the Island.

The final achievements of the reconnaissance survey were:

- The identification of the range of soil types present across the Islands and their placement in the current soil classification used by the FAO (1998), which will enable them to be incorporated into the current versions of the 1:5,000,000 scale Soil Map of the World and Soil Geographic Database of Eurasia and Mediterranean Countries at 1:1,000,000 scale (Lambert, *et al*, 2001).
- The development of a prototype soil classification based on the textural profile, depth, lithological and anthropogenic characteristics of Maltese soil types. The classification is derived from data collected during the limited reconnaissance soil survey and the results of the initial 16 Inventory point descriptions. It will provide the framework for characterising the physical and chemical properties of Maltese soils as they influence land capability and the environmental impacts of land utilisation (groundwater vulnerability, heavy metal contamination).
- The identification of a series of soil landscapes, in order to provide a context for quantifying the spatial variation of Maltese soil properties. The landscapes were identified using a combination of the height of the terrace, slope and underlying geology as it affects soil characteristics. An estimate of the range of soil types in each Landscape Class, according to the proposed soil classification systems was also made. It is proposed that the Soil Landscape Classes be used to target the phase 2 survey activities aimed at quantifying small-scale spatial variation of soil properties such as depth, texture, organic carbon content and possibly nutrients.

A description of the FAO (1999) soil classes recognised so far is included in Appendix 6, together with the proposed Soil Landscape Classification. In both cases, examples of Inventory sites conforming to the soil classes are given.

Finally, to assist field staff in classifying the soils at Inventory sites, 'Question and Answer' flow charts based on information recorded on the Inventory data recording cards were developed for both the FAO soil classes and the physical property classes. Following the visit of Maltese project staff to Silsoe in July, the flow charts were tested with newly recorded field information and as a result small amendments were made to the charts and to the Field Recording forms. The resulting flow charts are attached as Appendix 7.

3.1.4.1. References

- FAO (1998) World Reference Base for Soil Resources. World Soil Resources Reports No. 84. FAO, Rome. 88pp.
- Kubienna, W.L. (1953) The Soils of Europe. Thomas Murby & Co., London. 317pp.
- Lambert, J.J., Daroussin, J., Eimberck, M., Jamagne, M. King, D. & Le Bas, C. (2001) Soil Geographic Database of Eurasia and Mediterranean Countries at 1:1,000,000 scale – Version 4.0. European Commission, Joint Research Centre & INRA. 56pp.
- Lang D.M. (1960) Soils of Malta and Gozo. Colonial Office Colonial research Studies report No. 29. HMSO, London. 112pp.

3.1.5. Grid Survey

The full island grid survey started during the period of this report. Some 300 target sites were identified and the field staff began to visit these sites to record field information and collect the requisite soil samples as described above. An extract of the data recorded is presented in Appendix 8. A total of 68 grid locations were surveyed till the end of August 2002, producing a total of 164 soil samples.

3.2. Soil Laboratory Activities and Products

3.2.1. Review of Maltese Soil Laboratory Systems

NSRI laboratory staff visited the Maltese Soil Laboratory from 19th to 21st June 2002 to review the systems in place for sample receipt and processing. In advance of this, the Maltese team had reviewed the existing Standard Operating Procedures (SOPs) for laboratory analysis and provided these to NSRI for comment.

The GLP inspection documents of the NSRI laboratory were used as the basis of the visit to the Maltese Soil Laboratory. This highlighted areas that required attention to meet commonly recognised accreditation standards. The visit was used to review the system that is used to receive analytical samples and subsequent preparation and storage facilities. Analytical procedures were reviewed and advice given on data recording that would provide an improved audit trail.

3.2.2. Training

A group of five Maltese national team members attended a five-day training programme at Cranfield University at Silsoe, UK, in Laboratory Techniques from Monday 29th July to Friday 2nd August, 2002. This course focused on laboratory methodology of soil analysis specifically for MALSIS samples. The course consisted of class sessions and laboratory observation sessions. Special reference was made to the international standard guidelines for the analysis of pH, cation exchange capacity, organic carbon, carbonate content and metals (lead, cadmium, chromium, zinc, copper, nickel and mercury). Good laboratory practice was also discussed in detail, and where necessary, examples of documentation were provided as guidelines. The programme for this course is attached as Appendix 9.

3.3. Information Systems Activities and Products

3.3.1. Training

A group of five Maltese national team members attended a five day training programme at Cranfield University at Silsoe, UK, in Soil Information Systems from Monday 8th to Friday 12th July, 2002. The programme for this course is appended to the report (Appendix 10).

This structured training program was based on a series of information and PC-based training sessions. After an initial day introducing the team to the GIS software the following four days focussed on the input and management of data, the viewing and querying of data, the production of effective maps for reports, and the enhancement and future uses of the software and data. The team were provided with information packs containing print-outs of the information and training session notes, and data-rich CD-ROMs, so that the team can re-visit the training sessions for the consolidation of knowledge gained during the training program.

3.3.2. Information System Architecture and Database Design

Following a process of consultation between the Maltese team and Cranfield, a provisional system architecture has been identified which will govern the forward design and implementation of the MALSIS. This design accommodates existing systems in place within the Soils Laboratory for collecting and analysing the results of laboratory determinations. The system design also identifies a series of candidate applications that will ultimately be positioned around the centralised database management system. Further to this design, a provisional data dictionary was developed for the main MALSIS database tables, designed to record the entries from the field sheets noted at each of the sample points (see Appendix 11).

3.3.3. Hardware and Software

During the period of reporting, a specification was drawn up for the required hardware and software to service the MALSIS information system. The items identified were put out for competitive tender to Maltese suppliers and orders placed. These items included centralised server and personal computing resources, associated database (MS Access) and GIS software (ESRI ArcView and Spatial Analyst plus MapExplorer).

The list of IT hardware and software items ordered for the MALSIS project is provided at Appendix 12.

3.3.4. Digital Basemaps

A series of digital basemaps were procured for the MALSIS project by the Ministry of Agriculture and Fisheries, at no direct cost to the project. These basemaps provide a backdrop to the spatial elements of the information system and will greatly assist the development of the soil-landscape modelling within the GIS, and resultant applications drawing upon the database. The basemaps included are as follows (coverage of all islands unless stated):



- 1:1,000 vector basemap (urban areas)
- 1:2,500 vector basemaps
- Digital orthorectified aerial images (colour, 25cm pixel resolution)
- DTM (100m interval) [TIN, Shade, Aspect and Hillslope were subsequently derived]
- Contours
- Council boundaries.

3.4. Project Direction and Strategy Activities and Products

3.4.1. Soils Office

Pursuant to the goal of the sustainability of the Soils Office beyond the period of the MALSIS project, it was considered important to orientate the Office, positioning it towards the future monitoring of soils-related properties. Accordingly it is suggested that the Soil Laboratory and Office should be renamed the “**National Soil Unit**”. A business plan was drawn up for the National Soil Unit providing a forward plan for the years 2003 – 2005 in line with the Ministry’s vision. A copy of the business plan is attached as Appendix 13.

3.4.2. Soils Committee

Initial discussions have been held with key staff within the Ministry of Agriculture and Fisheries (MAF) as to the composition of the Soils Committee and its remit. There is general agreement that a wide range of stakeholders should be represented and that membership should include representation from Government and the agricultural industry. The Committee will have an advisory role with individual members accepting responsibility to act as "ambassadors" for the proposed National Soil Unit within their individual fields of activity.

The next stage is to identify individuals to whom approaches should be made within the respective chosen stakeholder organisations. These invitations will come from MAF as the Secretariat to the Committee. Candidate organisations may include the Ministry for Resources and Infrastructure, Malta Environment and Planning Authority, the Malta Resources Authority, and the Farmers Associations.

3.4.3. Dissemination and Publicity

A very important component of the MALSIS project is the successful dissemination of the project. This includes information made available as the survey commences and proceeds, as well as when the results are available. It is very important that the farming community and other stakeholders in MALSIS are kept apprised of the objectives and the developments within the project. Accordingly, a series of dissemination and publicity events have been staged during the reporting period. These events are summarised in the table below:

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Activity	Date	Title	Coverage
Press release	26 th January 2002	L-Unjoni Ewropeja se tiffinanzja parti minn progett ta' stharrig dwar il-Hamrija	Newspapers: The Times In-Nazzjon Television stations: PBS
Newspaper interviews	20 th – 26 th June 2002	EU funding 60% of Soil Information system project	The Malta Business Weekly The Malta Independent on Sunday
Radio interviews	Sunday 23 rd June 2002	Frott Artna	PBS Radju Malta
Promotional fairs	3 rd – 7 th April 2002 26 th June – 7 th July 2002	Green Week fair at the Trade Fair grounds, Naxxar International Trade Fair of Malta at the Trade Fair grounds, Naxxar	Posters, manned stands Posters, manned stands
Competition for the public	1 st July – 31 st July 2002	MALSIS Competition for the public linked with prizes	General public
Promotional leaflets	26 th June – 7 th July 2002	MALSIS – Sistema ta' Informazzjoni dwar il-Hamrija ta' Malta	5000 copies printed; 2500 copies distributed with monthly farmers' magazine 'Biedja u Sajd'.
Video production	Ongoing (March 2002 – February 2004)	MALSIS, A Soil Information System for the Maltese Islands	
Website	Under construction	MALSIS, A Soil Information System for the Maltese Islands	

3.4.4. Key Products from MALSIS

The key products anticipated from MALSIS have not altered significantly from the original proposal document. However, as the project has progressed, these products have been reviewed to ensure the information flowing from MALSIS is timely and effective in addressing contemporary issues in Malta. MALSIS datasets, information and interpretations are still anticipated to support the management of issues including groundwater vulnerability, land quality and suitability, waste management and soil fertility.

3.4.5. Project Resources, Facilities and Infrastructure

Prior to the official launch of the project, the offices of the Agricultural Chemistry Laboratories were refurbished and redecorated. The works carried out were aimed at upgrading infrastructural facilities and enhancing office space for MALSIS team members. Improvements were made to relocate the sample preparation area and to establish a soil archive. This is a constant environmental conditions (temperature and humidity) controlled chamber for storing and archiving soil samples complete with air-conditioning, shelving and storage units. For this reason, a room was identified and has been refurbished and equipped to provide a temperature-controlled, humid-free environment for the long-term storage of archive soil samples. The archive samples are being shelved in clean sealed plastic bags placed inside labelled cardboard boxes.

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The purpose of setting up the soil archive is to ensure that soil samples can be stored in stable conditions indefinitely thus providing a means whereby additional parameters may be analysed in future when resources become available. This is particularly relevant for parameters of interest, such as trace metals, organic compounds and pesticides that are not to be analysed during the project period. Owing to the hot climate in the Maltese Islands, especially during the summer months, it was necessary to provide a means to store the samples in a cool environment where the chemical composition would not change with time.



The premises of the National Soil Unit

3.5.5 Project National Team

During the project cycle, some changes were made to the national team. These changes did not affect the implementation of the project because no major changes were made to the project direction and management. The list of team members during the period under review is provided at Appendix 14. Each team member was provided with a detailed job description outlining his/her responsibilities as a MALSIS project member. An example of the job descriptions for the technical field survey member is provided at Appendix 15.

4. FINANCIAL STATEMENT OF EXPENDITURE

The financial statement of expenditure for the period 1st March to 31st August 2002 is presented as Appendix 16.

5. FORWARD PROJECT WORKPLAN

The following chart presents the current project plan, describing the timings of the principal project activities. The shaded boxes in bold represent the key milestones in the project:

Project Year One	03/02 Mar M1	04/02 Apr M2	05/02 May M3	06/02 Jun M4	07/02 Jul M5	08/02 Aug M6	09/02 Sep M7	10/02 Oct M8	11/02 Nov M9	12/02 Dec M10	01/03 Jan M11	02/03 Feb M12
Stakeholder Interviews	X											
Survey Planning		X	X									
Survey Phase 1 – Reconnaissance Field Survey			X	X	X	X	X	X	X	X	X	X
Surveyor Training			X	X	X	X	X	X	X	X	X	X
Survey Phase 2 - Grid Field Survey			X	X	X	X	X	X	X	X	X	X
Sample Planning & Design			X	X	X	X	X	X	X	X	X	X
Progress Reporting						X						
Sample Analysis & QA								X				
Information Systems - Logical Modelling				X								
Information Systems – Physical Modelling					X		X					
Information Systems - Data Loading								X				
Information Systems – Geostatistical Validation									X			
Workshop – Progress of Research Project												X

Project Year Two	03/03 Mar M1 (M13)	04/03 Apr M2 (M14)	05/03 May M3 (M15)	06/03 Jun M4 (M16)	07/03 Jul M5 (M17)	08/03 Aug M6 (M18)	09/03 Sep M7 (M19)	10/03 Oct M8 (M20)	11/03 Nov M9 (M21)	12/03 Dec M10 (M22)	01/04 Jan M11 (M23)	02/04 Feb M12 (M24)
Survey Phase 2 – Grid Field Survey	X	X	X	X	X	X	X	X				
Survey Phase 3 – Soil Variability		X	X	X	X	X						
Survey Phase 4 – Site Investigation		X	X	X	X	X	X	X				
Sample Analysis	X	X	X	X	X	X	X	X	X			
Information Systems - Data Loading	X	X	X	X	X	X	X	X				
Progress Reporting						X						
Information Systems – Geostatistical Validation						X						
Information Systems – Production of Thematic Maps								X	X			
Review options for future sustainability of soil office										X	X	
Update Internet information on project										X	X	
Workshop – Dissemination of Research Findings										X		X
Final Reporting										X	X	X

6. CONCLUSIONS

The MALSIS project is running smoothly and on-target. The products and deliverables resulting from each of the key phases of activities will directly assist the Ministry of Agriculture and Fisheries discharge its duties pertaining to soil management and compliance with EU Directives and other instruments. By the end of the next six-month phase of activity there will be preliminary results recorded from the grid survey programme.

7. APPENDICES

The following appendices provide supporting information for the main report and include the working documents for the MALSIS project developed to date as well as records of the main activities.

7.1 Appendix 1 – Soil Sampling and Field Survey Techniques Training Programme

Three training programmes have taken place within the period of this progress report as follows:

- Field Survey Techniques from Monday 13th to Friday 17th May 2002
- GIS from Monday 8th to Friday 12th July, 2002.
- Laboratory Techniques from Monday 29th July to Friday 2nd August, 2002



Aims:

To promote a general awareness of soils to a group with a diverse array of skills; to demonstrate the assessment and description of elements of soil survey relevant to the Malta project, then to direct the group into developing these specific skills for use in Malta.

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Objectives:

1. to promote a general awareness of soil;
2. to teach theoretical aspects of the more important elements of site and soil profile description;
3. to demonstrate these elements with practical experience for the group using soil samples from the UK;
4. to discuss and develop soil sampling techniques, equipment requirements and data recording;
5. to practice soil description and sampling in the field on farm visits; and
6. to review the progress and ascertain the needs of the next stage.

Programme 13–17 May 2002 based at Silsoe, Bedfordshire:

Day 1

- Introduction to soils
- Soil awareness
- Soil formation
- Elements of field description (FAO & NSRI Field Handbooks)
- Practical session, including hand texturing, estimation of carbonate content, field pH, structure

Day 2

- Further elements of field description (FAO & NSRI Field Handbooks)
- Soil sampling: theory and the proposed scheme for Malta
- Field recording – the soil description card, its design, the user manual and filling the card in
- Equipment needed
- Sample handling, field to laboratory

Day 3

- Field Practical – visit to *Farmers' Weekly* limestone farm near Stamford, Lincolnshire, to develop skills in pit digging, horizon differentiation, hand texturing, colour recording, slope measurement, etc.

Day 4

- Strengthening of course work in direct relationship to conditions in Malta
- FAO soil classification, especially urban and man-made soils

Day 5

- Field Practical – soil profile description and catena demonstration on chalk soils
 - Groundwater vulnerability principles and assessment
- Assessment of the week's course and ascertaining future needs

Daily Review:

At the end of each day, the sessions covered will be discussed and reviewed.

Program Review:

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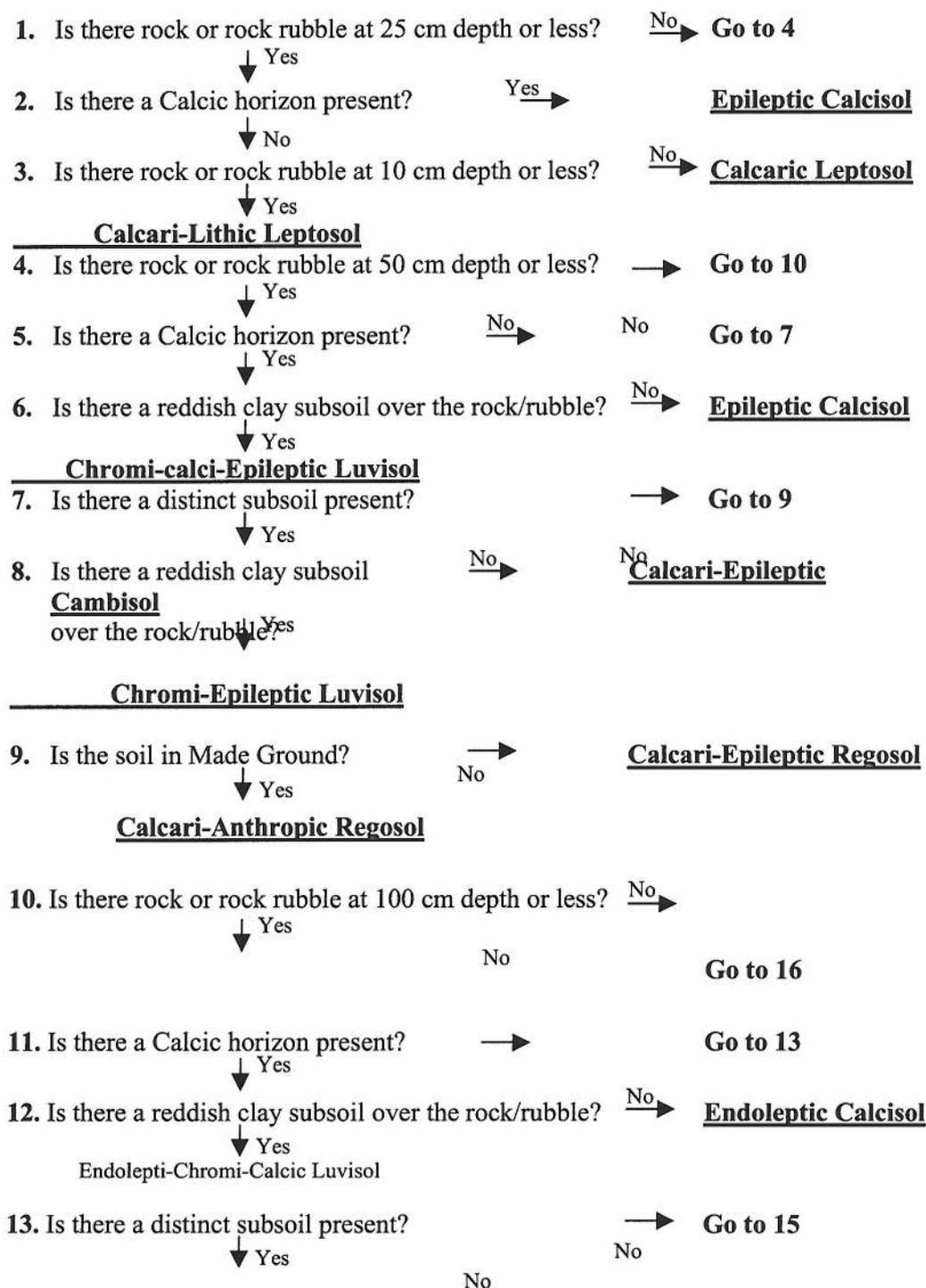


At the end of the training program the contents will be discussed

Information Sessions:

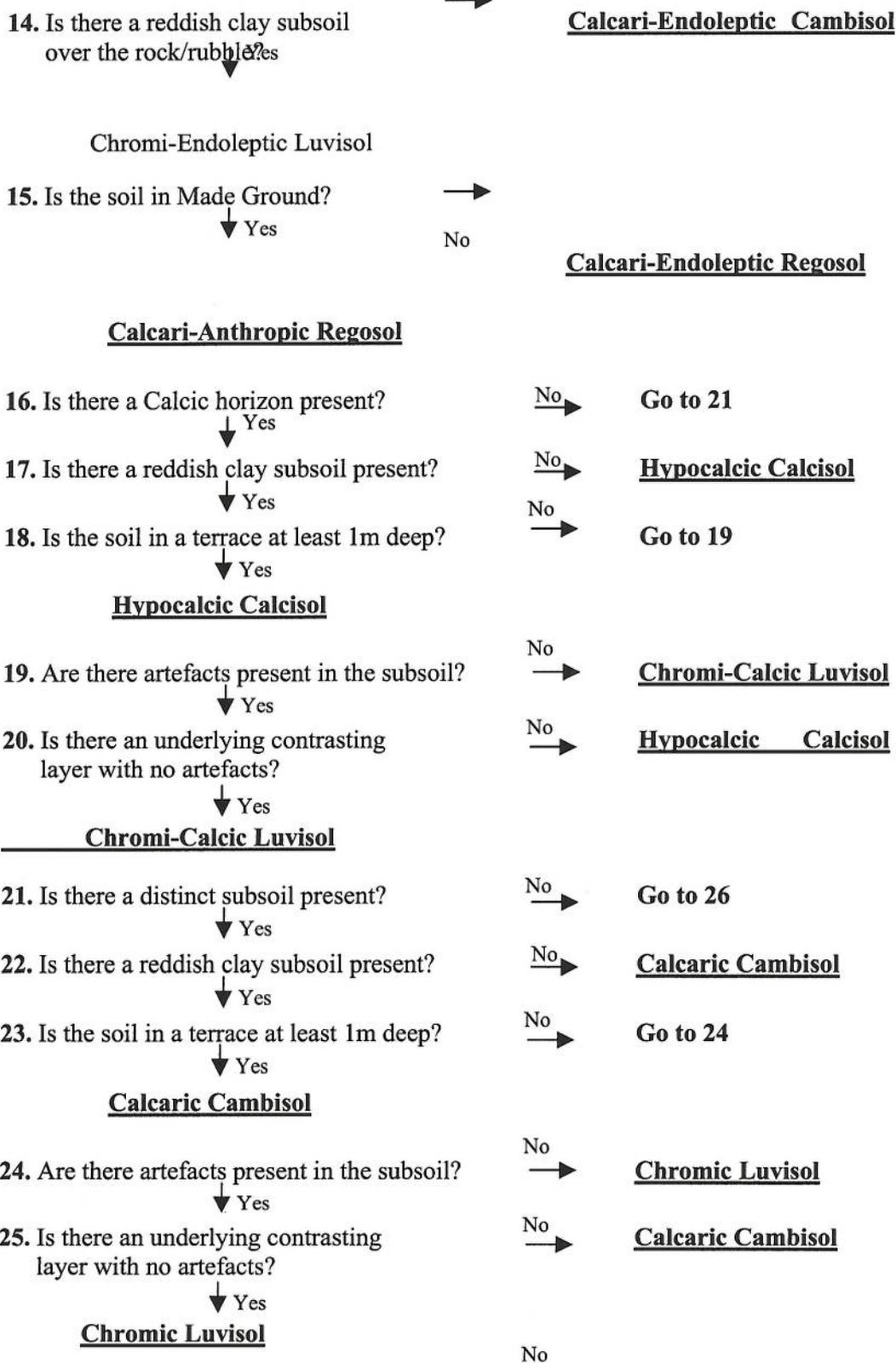
Individual sessions will consist of a mix of tutor-led instruction and hands-on practical exercises.

7.2 Appendix 2: FAO Soil Classification Flow Chart for Maltese soils



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26. Is the soil in Made Ground?
Yes



Calcaric Regosol

Calcari-Anthropic Regosol

7.3 Appendix 3: Topological maps and aerial orthophotographs

7.4 Appendix 4: Digital images of grid locations



7.5 Appendix 5: Field protocol and field recording forms

The Target Population

The purpose of the Inventory is to obtain unbiased information about the soils of Malta, defined as occupying land above sea level. It includes all land currently used for agriculture, woodland, horticulture and fruit growing. All wild land, for example, saltmarsh, garigue and wetland is of interest. So also is open amenity land, such as public spaces and recreation areas. All this land constitutes the target population. It will include grossly disturbed land, reclaimed land and 'made' land. It will include field boundaries, ditches and places where harbour dredgings, 'moved' soil, waste sites and land close to field entrances and farm yards. Sampling sites occurring on such land are atypical, of course, but they are part of the total land surface, and for this survey must be described. Only in this way can an unbiased picture of the soil of Malta be obtained.

Sampling scheme

The sites to be visited occur at regular 1 km intervals offset 500 metres from the principal 1 km points on the Maltese National Grid.

Finding sites

Bias in locating sites must be avoided; i.e. personal preference is not permitted. Location of sites accurate to at least 10 m will be possible using 1:2,500 scale maps and conventional site finding.

The following procedure is recommended for finding the sites:

- Choose from the map or air photograph some easily recognisable feature near the grid point, and go there. Estimate from the 1:2,500 scale map the direction and distance to the grid point, and go there.
- Using either a compass or some other means of siting to give direction, measure the final few metres to the point using the measuring wheel.
- Stop, and mark site.
- It is recognised that at the time of writing (June 2002) the GPS available to the project will only read out in latitude and longitude. It is therefore suggested that conventional means of locating sites are employed until a read out in metres can be obtained.
- Do not look around for 'typical', convenient or pleasant places to dig. Do not shorten or lengthen paces to avoid any kind of ground.
- Record the grid reference of the target site and also record the reading from the GPS where you dig the pit. The reading in latitude and longitude degrees can be converted to metres to access accuracy.

It is essential that the FULL grid reference is recorded on the form so that there is no doubt as to which site has been visited.

Deviations

Where the soil at a grid intersect is inaccessible (road, building, wall or other field boundary, etc., or where there is no soil present (rock or water), the following procedure is to be followed.

If there is rock at the surface, record the proportions of rock to soil in the rock box. If there is no soil within a 4 x 4 metre square, as assessed from the 25 sampling points, follow the protocols below.

Record the reason for not being able to observe the soil at the target 1 km grid point. Choose a substitute site 20 m North. If the site there is inaccessible, then choose a site 20 m East or South or West, in that order **from the original grid point**. If that fails to give access, then repeat at 40 m distance. If that also fails then repeat at 80 and 100 m distance, **again from the original grid point**. Finally, if that fails, abandon the site and record the reason.

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Record the true grid reference of the substitute, not the original intersect. The computer can be programmed to recognise the latter.

In urban areas, where inaccessibility can be inferred from the map or air photography, record only the grid reference, your initials and the reason for non-access.

Observation and recording

For the Inventory, small pits are to be dug to 50 cm and the soil inspected by auger to 100 cm in the bottom of the pit if possible, or shallower where rock intervenes. Properties to be recorded are given on the recording proforma.

Do not trample round the site as this will affect subsequent sampling.

- Take bulk density tins (3) from topsoil and label with reference and depth.
- Take the topsoil horizon sample from around bulk density tins and label H1. The material taken from around the tins will give a good idea of the topsoil structure. Take a horizon sample even if you can not take tins.
- Take 25 topsoil samples in a grid pattern using the protocols described below.
- Record the site details.
- Annotate the field map to show the target and actual sites.
- Measure the slope angle (maximum slope) and aspect.
- Dig hole to 50 cm, noting depths of horizons, also the material taken the pit will give a good idea of the topsoil and subsoil structures.
- Take the penetrometer readings from each horizon (3 and average).
- Take bulk density tins (3) at 50 cm depth and label with reference and depth.
- Take a sample of subsoil from around bulk density tins and label with reference and depth. Take a horizon sample even if you can not take tins.
- Describe the topsoil.
- Auger into the base of the pit, noting depths of any horizons.
- Complete description of subsoil horizons.
- Take photographs in the order looking north, looking east, looking south and looking west standing 5 m from the target spot. Make a note of any distinctive features present.

It is essential that all the features are recorded on the form so that there is no doubt as to what is present at the site. If it is not possible to record a given feature, note the reasons why.

Subsoils

Note that subsoil properties such as structure can be determined from the pit but not from the auger. Only texture, colour and an approximate estimate of stone content (limited to stones less than 6 cm in size) can be recorded from an auger. If there are more than three horizons, record details of the remainder on a separate form if you think it forms a significant horizon, otherwise in free hand script on the bottom of the form.

Bulk density samples

Drive three tins into each layer to be sampled and carefully remove together. Use a trowel to excavate the tins and carefully insert the trowel under each tin in turn and remove from the pit. Gently level the top of the tin and cover with a lid then invert, gently level the base and cover. Place the three tins in the same bag and label.

Stony soils: if the stones are more than 3 cm in size then do not try to take bulk density tins as the results will reflect the stones not the soil content. **Note: do not use too much force in stony soils as this may bend the cutting ring and/or distort the sampling tool.**

Clayey and/or dry soils: it is possible that the tin will not be completely full however carefully the guidelines are followed. It is allowable to add some soil to fill the gaps left in the tin. If more than 5% is required try again.

Bulk samples

Bulked samples of the topsoil are to be taken using a mild-steel, screw or gouge auger. However, if the soil is too dry to remain on the auger use a trowel at each point.

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Do not use plated augers because of the high risk of contamination by metals from the plating.

Take 25 cores from the surface of the soil to 15 cm, or shallower if rock intervenes. The target sample mass is a minimum of 1.5 kg of air dry soil (excluding stones). If the 25 cores fail to yield this much material, repeat the coring at offsets of 0.5 m within the sampling grid until you judge that the target mass has been obtained. Take more soil rather than less. The surface in this context is the zero of measurement, i.e. excluding living vegetation and litter.

Put the soil in a polythene bag.

Write the grid reference and MALSIS reference number on the label, together with **B** (meaning the bulked topsoil sample), the date of sampling, your initials, the depth range of the sample (for example, 0-15 cm) and the **actual** grid reference **clearly** on the label using a pen with waterproof ink (avoid the use of red ink as the colour can fade rapidly). Place the first polythene bag inside another and place the label (written side outwards) between the bags, and finally tie the bags closed.

The samples should be taken at approximately 1 m intervals with a 4 m X 4 m square normally with the pit at its centre. However, if the pit is close to a field boundary or obvious physiographic boundary, displace the square so that only the one field or physiographic unit in which the pit occurs is sampled.

Horizon samples

The horizon samples are designed to characterise both the horizons and the soil in the bulk density tins. Take the topsoil horizon sample from around bulk density tins and label **H1** together with the grid reference and depth. The subsoil sample will be taken from the pit at the same depth as the bulk density tins. As with the topsoil samples, put the subsoil sample in a double polythene bag and label with the grid reference, MALSIS reference and **H2** and finally tie the bags closed.

To avoid changes in, for example, available P resulting from biological activity, the samples should be transferred to a cool box at the earliest opportunity. Such changes can be diminished if the samples are stored in a refrigerator while awaiting transfer to the laboratory.

Please do not leave the samples in the sun or in a vehicle where they can become very hot. Such 'cooking' can greatly alter some soil properties and make the resulting data of little value.

Horizon parameters

Record the colour of each horizon in the moisture state you find in the field and also from the piece of moist soil you use for texture.

It is allowable to indicate ranges of values in size for stones and structure. However, do not circle more than 2 classes.

When all sampling is complete, fill in the hole with the last material removed replaced first. Level the surface and tidy the site of all debris before leaving.

After the field session

On return to the office:

- File the profile descriptions.
- File the field maps.
- Hand in the samples for registration.
- Download the photographs.
- Plan the next field session – what is required to visit the next sites (labour, plastic bags, tins, recording forms and labels).

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Field Recording Form

Grid Ref - Target (m)	E	<input style="width: 95%;" type="text"/>	N	<input style="width: 95%;" type="text"/>
Grid Ref - Actual (m)	E	<input style="width: 95%;" type="text"/>	N	<input style="width: 95%;" type="text"/>
Grid Ref - GPS	N	<input style="width: 95%;" type="text"/>	Survey Sheet No. <input style="width: 100%;" type="text"/>	
Grid Ref - GPS	E	<input style="width: 95%;" type="text"/>		
Project Ref. No.	<input style="width: 100%;" type="text"/>			

Observers <input style="width: 100%;" type="text"/>	Date <input style="width: 100%;" type="text"/>	Altitude <input style="width: 95%;" type="text"/> m <input style="width: 5%;" type="text"/> ft
--	---	---

Slope % <input style="width: 100%;" type="text"/>	Aspect <input style="width: 100%;" type="text"/>	Form <input style="width: 100%;" type="text"/>
--	---	---

Photograph Ref	north	east	south	west
----------------	-------	------	-------	------

Sketch plan of site

N

S

Inaccessible at Target										
As	Cn	Bd	Fb	Gh	Ar	Es	Ht	Wt	Br	Qr

Rock outcrop							
N	V	F	C	M	A	D	

Non Agric. Land Use				
Wd	Ga	Ma	St	Ab

Human impact										Terrace height (cm)			
Un	MG	Bu	DC	Dr	DL	DNL	TrM	TrW	DV	Tr			

Agric. Land use												
Fw	Cr	Pt	Tm	Wm	Vg	Fd	Sc	Fl	Co	Ol	Ft	Vn

Irrigation				
NI	IU	SI	DI	CI

Soil Surface Condition				
Unsk	Ptl Skd	Skd	Slk Capd	Capd

Surface Vegetation Cover %				
0	0-15	15-40	40-80	> 80

Man Made Surface Form		
Furrd	Mound	Fltnd

Man Made Surface Channels			
VWX	VWUD	RFX	RFUD

Erosion & Deposition				
GR	ShE	WE	ExD	MnD

Free Text

Samples	
Bulk sample taken of topsoil - grid	<input style="width: 95%;" type="text"/>
Horizon sample taken of topsoil	<input style="width: 95%;" type="text"/>
Horizon sample taken of subsoil	<input style="width: 95%;" type="text"/>

Number of tins	
Top soil	<input style="width: 95%;" type="text"/>
Sub soil	<input style="width: 95%;" type="text"/>

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Depth	PSC	Structure	Size
<input type="text"/>	<input type="text"/>	SG MA VW WE MO ST VS	VF FI ME CO VC
	% C <input type="text"/> % S <input type="text"/>	Stone	
Horizon		Ab <input type="text"/> Size <input type="text"/> Nature <input type="text"/>	Shape
<input type="text"/>			PL PR AB SB GR ND
	Roots		
Nodules (nature)	Ab <input type="text"/>	Ab <input type="text"/> Size <input type="text"/> Nature <input type="text"/>	Moisture
? Ca Fe <input type="text"/>		wdy fbr fsh	dry s mst mst v mst
Matrix			
<input type="text"/>		Mottle	Penetration
		<input type="text"/>	<input type="text"/>
Moist rubbed colour		Mottle 2	Artefacts
<input type="text"/>		<input type="text"/>	Y N
Boundary form	Shape	Free text	
A C G D	S W I B ND	<input type="text"/>	

Depth	PSC	Structure	Size
<input type="text"/>	<input type="text"/>	SG MA VW WE MO ST VS	VF FI ME CO VC
	% C <input type="text"/> % S <input type="text"/>	Stone	
Horizon		Ab <input type="text"/> Size <input type="text"/> Nature <input type="text"/>	Shape
<input type="text"/>			PL PR AB SB GR ND
	Roots		
Nodules (nature)	Ab <input type="text"/>	Ab <input type="text"/> Size <input type="text"/> Nature <input type="text"/>	Moisture
? Ca Fe <input type="text"/>		wdy fbr fsh	dry s mst mst v mst
Matrix			
<input type="text"/>		Mottle	Penetration
		<input type="text"/>	<input type="text"/>
Moist rubbed colour		Mottle 2	Artefacts
<input type="text"/>		<input type="text"/>	Y N
Boundary form	Shape	Free text	
A C G D	S W I B ND	<input type="text"/>	

Depth	PSC	Structure	Size
<input type="text"/>	<input type="text"/>	SG MA VW WE MO ST VS	VF FI ME CO VC
	% C <input type="text"/> % S <input type="text"/>	Stone	
Horizon		Ab <input type="text"/> Size <input type="text"/> Nature <input type="text"/>	Shape
<input type="text"/>			PL PR AB SB GR ND
	Roots		
Nodules (nature)	Ab <input type="text"/>	Ab <input type="text"/> Size <input type="text"/> Nature <input type="text"/>	Moisture
? Ca Fe <input type="text"/>		wdy fbr fsh	dry s mst mst v mst
Matrix			
<input type="text"/>		Mottle	Penetration
		<input type="text"/>	<input type="text"/>
Moist rubbed colour		Mottle 2	Artefacts
<input type="text"/>		<input type="text"/>	Y N
Boundary form	Shape	Free text	
A C G D	S W I B ND	<input type="text"/>	

Summary description of deeper horizons:

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List of Parameters Recorded on Field Form

Observer	AAB	Notes
Anthony A Borg	AAB	∞Use ND where parameters are not determined (particularly for deeper subsoils)
Sharlo P Camilleri	SPC	
William M Camilleri	WMC	
Sonya J Vella	SJV	∞Make a circle around the chosen code to confirm the observation

Slope Gradient	%	Form
Flat	0 - 0.2	S Straight
Level	0.2 - 0.5	C Concave
Nearly level	0.5 - 1.0	V Convex
Very gently sloping	1.0 - 2	T Terraced
Gently sloping	2 - 5	X Complex
Sloping	5 - 10	
Strongly sloping	10 - 15	
Moderately steep	15 - 30	
Steep	30 - 60	
Very steep	>60	

Agricultural Land Use & Management

Fw	Fallow	
Cr	Cereal	
Pt	Potatoes	Ma
Tm	Tomatoes	
Wm	Water melons	
Vg	Vegetables	
Fd	Fodder	
Sc	Other summer crops	
Fl	Flower crops	
Co	Citrus orchards	
Ol	Olive plantations	SI
Ft	Fruit trees	
Vn	Vines	

Non Agricultural Land Use

Wd	Woodland
Ga	Garigue
Ma	Maquis
St	Steppe
Ab	Abandoned land

Irrigation

NI	Not irrigated
IU	Irrigated (unspecified)
SI	Sprinkler irrigation
DI	Drip irrigation
CI	Channel irrigation

Human Impact

Un	Undisturbed soil (normal cultivation depth)	As
MG	Made Ground	
Te	Terraced	Bd
DC	Deeply Cultivated soil	
Dr	Disrupted soil	
DpL	Deepened soil – local material	Ar
DpNL	Deepened soil – non-local	Es
TrM	Truncated soil – man made	
TrW	Truncated soil – un managed water	Wt
DrV	Seasonally Dry river valley	
Bu	Buried soil	

Inaccessible at Target

As	Asphalt cover
Cn	Concrete cover
Bd	Buildings
Fb	Field boundary
Gh	Greenhouse
Ar	Archaeological site
Es	Environmentally sensitive area
Ht	Hard standing track
Wt	Water – large ponds and reservoirs
Br	Bare rock
Qr	Quarry

Man Made Surface channels

Furrd	Furrowed
Mound	Mounded
Fltnd	Flattened

Soil Surface Condition

Unslk	Unslaked
Ptl Slkd	Partly slaked
Slkd	Slaked
Ptl Capd	Partly capped
Capd	Capped

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Man Made Surface Channels

VWX Vehicle wheeling across slope
 VWUD Vehicle wheeling up / down slope
 RFX Ridges & furrows across slope
 RFUD Ridges and furrows up/down slope

Erosion & Deposition

GR Gullies/rills present
 ShE Sheet erosion present
 WE Wind erosion evident
 ExD Extensive deposition -over half the field
 MnD Minor deposition -less than half the field

Rock outcrops

N None 0%
 V Very few 0 - 2%
 F Few 2 - 5 %
 C Common 5 - 15%
 M Many 15 - 40%
 A Abundant 40 - 80%
 D Dominant > 80%

Boundary form

A Abrupt 0 - 2cm
 C Clear 2 - 5cm
 Gradual 5 - 15cm
 Diffuse >15cm

Boundary shape

S - Smooth nearly plane surface
 W - Wavy pockets less deep than wide
 I - Irregular pockets more deep than wide
 B - Broken discontinuous

Particle Size Class

C Clay
 L Loam
 CL Clay loam
 Si Silt
 SiC Silty clay
 SiCL Silty clay loam
 SiL Silty loam
 SC Sandy clay
 SCL Sandy clay loam
 SL Sandy loam
 LS Loamy sand
 S Sand

Structure Grade

VW Very weak
 WE Weak
 MO Moderate
 ST Strong
 VS Very strong

Structure Shape

PL Platy
 PR Prismatic
 AB Angular blocky
 SB Subangular blocky
 GR Granular

Moisture

dry dry
 s mst slightly moist
 mst moist
 v mst very moist

Artefacts (present)

Y Yes
 N No

Structure Size

Symbol	Class	Platy (mm)	Prismatic (mm)	Blocky (mm)	Granular (mm)
VF	Very fine	<1	<10	<5	<1
FI	Fine	1 - 2	10 - 20	5 - 10	1 - 2
ME	Medium	2 - 5	20 - 50	10 - 20	2 - 5
CO	Coarse	5 - 10	50 - 100	20 - 50	5 - 10
VC	Very coarse	>10	>100	>50	>10

Stone / Nodule Abundance

N None 0 %
 V Very few 0 - 2 %
 F Few 2 - 5 %
 C Common 5 - 15 %

Stone Size

F Fine gravel 0.2 - 0.6cm
 M Medium gravel 0.6 - 2cm
 C Coarse gravel 2 - 6cm
 Stones 6 - 20cm

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M	Many	15 – 40 %	B	Boulders	20 – 60cm
A	Abundant	40 – 80 %	L	Large boulders	>60cm
D	Dominant	>80 %			
Mottle Abundance			Stone Nature		
N	None	0 %	L	Local	N Non Local
V	Very few	0 - 2 %	Mottle Size		
F	Few	2 – 5 %	V	Very Fine	< 2mm
C	Common	5 – 15 %	Fine	2 – 6mm	
M	Many	15 – 40%	M	Medium	6 – 20mm
A	Abundant	> 40%	C	Coarse	>20mm

Root	no. of roots	Abundance	Root Size			Nature	
N	No roots	0	VF	Very fine	< 0.5mm	Wdy	Woody
V	Very few	1 – 20	F	Fine	0.5 – 2mm	Fbr	Fibrous
F	Few	20 – 50	M	Medium	2 – 5mm	Fsh	Fleshy
C	Common	50 – 200	C	Coarse	>5mm		
M	Many	>200					

7.6 Appendix 6: First Estimation of Soil Classes and Soil Landscapes

Summary of FAO Soil Types identified during Reconnaissance.

LEPTOSOLS

Very shallow soils with limited development because of Rock or rock rubble at 25 cm depth or less.

Calacri-Lithic Leptosols:

A/C; 2R. (*estimated occurrence, no profile examined*)

Mainly on the vertical cliff faces where very thin weathered layer of soil overlies rock at less than 10 cm depth.

A/B; 2R. (*estimated occurrence, no profile examined*)

On level to gently sloping relatively undisturbed Garrigue, where rock is at less than 10 cm depth.

Calaric Leptosols: (The most common form of Leptosols)

A/B; 2R. (*profile at 4050 7450*)

On relatively undisturbed Garrigue (both on level and very steep slopes), where rock occurs at 10 to 25 cm depth.

Ap; 2R. (*see profiles at 4250 6950 & 5150 7550*)

On some terraces where 10 to 25 cm of topsoil directly overlies massive limestone.

VERTISOLS

'Cracking Clay' soils restricted to the Blue Clay outcrop in Malta. Recognised by their very clayey nature, the presence of deep, wide cracks during the summer months and the presence of a slightly 'gleyed' (faint grey & rusty mottles) very coarse prismatic subsoil horizon.

Calcic Vertisols:

Ap, Bw; BC(g)k. (*see profiles at 4360 7175 & 4650 675*)

The dominant soils on the Blue Clay outcrop.

Ap; A/B(k) and/or 2BC(g)k (*Estimated occurrence based on observation*).

Where thin terraced material derived from slope wash overlies Blue Clay)

CALCISOLS

Soils with limited development because of large calcium carbonate content and only short 'moist' seasons. They have no 'dark coloured' topsoil and only a weakly developed subsoil horizon (Ab or Bw) and are principally characterised by the presence of a 'calcic' horizon at least 15 cm thick. In Malta these horizons are recognized by the presence of 'secondary' CaCO₃ concentrations as coatings on soil structure faces and as 'pseudomycelia' (fine thread-like concentrations, often associated with roots). The calcic horizons may be present in the lower topsoil and/or the subsoil/substrate horizons.

Endoleptic Calcisols: The most common soils in Malta, over rock or rock rubble at 50 to 100 cm depth.

AB; Bwk; 2R. (*estimated occurrence, no profile examined*)

Mainly on uncultivated terraces on steeply sloping Coralline Limestone.

Ah/Cu; Cu/Ah; Ck; R. (*see profile at 4450 6760*)

Mainly on uncultivated terraces on steeply sloping Globigerina Limestone.

Ap; Ap(k) and/or ABk; 2BCk and/or 2R (*see profiles at 4150 7450, 4450 7450, 4650 7450 [part of pit only] & 4950 6750*)

The most common moderately shallow brown or reddish terraced soils over any limestone type.

Epileptic Calcisols:

Ap; Ap(k) and/or ABk; 2R. (*see profiles at 4850 7840, 4950 7852, 5550 6850, 5750 6750, 5905 7111 & 5970 6930*)

The shallower form of brown or reddish Calcisols on the shallow parts of terraces over any limestone type.

Ap; Ck; R. (*see profile at 6043 7033*)

The 'Grey' terraced soils on Globigerina Limestone.

Hypocalcic Calcisols:

Ap; ABk; 2Bwk; 3BCk? (*see profile at 4250 7750*).

The deep form of Calcisol in thick colluvial deposits (valley fill). Reddish or Brownish over reddish. Usually with pottery artefacts, 'foreign' dark stones and stone lines to at least 50 to 60cm depth, all indicating its 'recent colluvial' nature. Deeper parts of the profile (below about 1m – the 3BCk?) may be older than the Holocene and can cause problems in deciding whether the soil is a Luvisol or Calcisol.

Ap; ABk and/or Bwk. (*see profile at 4750 6750*).

The deepest brownish (or reddish?) terraced soil on thick terraced material with little horizon differentiation apart from the formation of secondary CaCO₃.

Ap; ABk; 2BC(g)k. (*estimated occurrence, no profile examined*)

Restricted to the upper parts of the Blue Clay outcrop where some part or the whole of the terraces have upper layers formed from a mixture of slope wash from the Upper Coralline limestone and the upper surface of the Blue Clay.

LUVISOLS

Soils with a clay-enriched 'argic' subsoil formed by weathering of clay from pure limestone, and/or from the 'washing-out' of fine clay particles from upper to lower horizons. In Malta, such soils are reddish clays and the result of soil development under different climatic conditions to those of today. They probably formed during the 'wetter' climates associated with Glacial advances in Northern Europe (Pleistocene 'Stadials'). They are now 'relict' soils and all contain secondary CaCO₃ concentrations (calcic horizons) reflecting the current predominant pedo-climatic regime in the Islands.

Chromi-calci-Epileptic Luvisols:

A/B, 2BCt'k; 3R. (*estimated occurrence, no profile examined*)

Shallow eroded remnants of former Luvisols in relatively undisturbed Garrigue, both on relatively level areas and steep slopes. Often present as 'solution pockets' in the Limestone surface.

Ap; 2B'tk and/or 2BCt'k; 3R. (see profile at 4250 7450)

Shallow eroded remnants of former Luvisols on shallow terraces, mainly on the Coralline Limestones. Some terraces have been deepened by adding topsoil material from elsewhere (see profile at 4352 6950).

Endolepti-chromi-Calcic Luvisols:

Ap; ABk and/or Bwk; 2B'tk and/or 2BCt'k; 3R. (see profiles at 5800 7160 & 5950 6750 and probably the one at 4348 7450)

Deeper soils on gentle lower terraced slopes of relatively undisturbed limestone areas. Upper parts of the profile often appear to be formed in colluvial slope wash and contain pottery artefacts and 'foreign' dark stones (see profile at 5950 6750).

Chromi-Calcic Luvisols:

Ap; ABk and/or Bwk; 2B'tk and/or 2BCt'k. (see profile at 5650 6850).

the deepest form of Luvisols probably where relatively thick Pleistocene colluvial material underlies more recent terrace or colluvial material within 1 m depth.

CAMBISOLS.

Soils with limited development showing only a 'distinct' subsoil with a significantly different (brownier or redder) colour to the topsoil but no characteristic 'calcic' or reddish clay 'argic' horizons.

Calcari-Endoleptic Cambisols:

Ap; Bw and/or 2R. (see profile at 4750 7350). Relatively rare occurrences on terraced landscapes, possibly because of recent disturbance or relatively low CaCO₃ content in the soil does not facilitate the formation of Calcic horizons.

REGOSOLS.

Soils with very limited development in virtually unaltered parent material, showing no 'dark coloured' topsoil and no distinct subsoil horizons.

Calcari-Epileptic Regosols:

Ap; 2Cu and/or 2R. (see the shallow part of profiles at 4250 7450 & 4650 7450)

On the shallow parts (usually the back) of terraces where at least 25 cm of topsoil directly overlies rock or rock rubble.

Ah/Cu; Cu/Ah; Cu; R. (estimated occurrence, no profile examined)

On very steep 'active' colluvial slopes under semi-natural Garrigue vegetation where the colluvium is 25 to 50 cm thick.

Ap; Cu; 2R. (see profile at 4650 7750). On 'greyish' terraces where the soil material is derived from soft limestone and no calcic horizons have formed.

Endolepti-Calcaric Regosols:

Ah/Cu; Cu/Ah; Cu; R.

(estimated occurrence, no profile examined)

On very steep 'active' colluvial slopes under semi-natural Garrigue vegetation where the colluvium is at least 50 cm thick.

Calcari-Anthropic Regosols:

Ap; AB and/or 2Cu. (see profile at 4850 6750)

In recently made terraces where a layer of rock rubble (the 2Cu layer) is spread over the rock base and topsoil spread over it at depths of 20 to at least 50 cm.

Spolic Regosols:

Ap; 2Cu. (*see profile at 4950 7750*). On 'made ground' terraces overlying urban waste material.

First Estimate of the Soil Landscapes of Malta

The landscapes of the Maltese Islands can be divided into; **semi-natural** landscapes, where very little evidence of man's activities can be identified; and **man-made** landscapes where the influence of man can be seen in widespread terracing of slopes, creation of 'made ground' or intensive cultivation. The terraces range in height from a few centimetres to several metres in amplitude and were constructed to reduce the risk of soil erosion under arable cultivation and maximise the rooting depth available for plant growth.

A. SEMI-NATURAL LANDSCAPES

1) Bare Sea Cliffs

These are dominated by vertical bare rock but differential hardness within the strata leads to the formation of narrow ledges and steep slopes with pockets of thin soil. Locally sea erosion into softer strata at the base of these cliffs makes this landscape unstable and cliff recession is on-going. The landscape comprises:

- **Rock outcrop & massive boulders.**
- **Calcari-Lithic Leptosols:** Carbonatic Ly lithoskeletal limestone
A/C; R at <10 cm. (*Estimated occurrence based on observation*)

2) Limestone pavement

Found on level or gentle slopes. Typified by the area around the cliff edge road at Dingli cliffs, common on the eastern cliff tops of Gozo and capping the mesas overlooking the blue clay valleys and on exposed high ground of the Coralline Limestone of north west Malta. The landscape comprises:

- **Rock outcrop.**
- **Calcari-Lithic Leptosols:** Reddish Ly Lithoskeletal Limestone.
A/B, 2R at 10cm or less. (*Estimated occurrence based on observation*)
- **Calcaric Leptosols:** Reddish Ly Lithoskeletal limestone
A/B, 2R at 10 to 25 cm. (*see profile at 4050 7450*)
- **Chromi-calci-Epileptic Luvisols:** Reddish F Ly over clayey material over lithoskeletal Limestone (in solution pockets in the Limestone).
A/B, 2Bt'k, 3R at 25 to 50(+?) cm. (*Estimated occurrence based on observation*)

3) Low Coralline Limestone bluffs.

Beds of resistant coralline limestone, particularly immediately above the junction with the Blue Clay formation, form 5-20 m high vertical rock bluffs. These bluffs are dominated by bare rock but large displaced or fallen boulders are common and Macchia vegetation widespread. Typical examples are beneath the promenade at Mdina, uppermost strata on the Dingli cliffs, flanks of the resistant caps to the mesas and butes on Gozo. The landscape comprises:

- **Rock outcrops and massive boulders**

- **Calcaric Leptosols:** Reddish Ly lithoskeletal limestone & terraced Reddish Ly lithoskeletal limestone
A/B, 2R at 10 to 25 cm. (*see profile at 4250 6950*)
- **Epileptic Calcisols:** Reddish F. Ly over lithoskeletal limestone.
AB; Bwk; 2R at 25 to 50 cm (*Estimated occurrence based on observation*).
- **Chromi-calci-Epileptic Luvisols:** Reddish F Ly over Cy material over lithoskeletal limestone (in solution pockets in the Limestone).
A/B, 2Bt'k, 3R at 25 to 50(+?) cm. (*Estimated occurrence based on observation*)
Endoleptic Calcisols: Cy (or F.Ly) terraced material over reddish Co Zy (to Cy) material over lithoskeletal Lst. (Brown soils in terraces at the base of the Upper Coralline Lst cliff)
Ap; 2Bwk; 3R at 50 to 100+ cm. (*see profile 4150 7450*)
Reddish F. Ly (or Cy) material over lithoskeletal limestone (reddish soils in terraces at the base of the Upper Coralline Lst cliff).
AB; Bwk; 2R at 50 to 100+ cm. (*Estimated occurrence*)

4) **Narrow Globigerina limestone bluffs**

Bare rock, macchia and scrub with a few uncultivated terraces for bird hunters, on very steep slopes on the Upper Globigerina limestone below the Blue Clay 'ledge' on the southern cliffs (seen at Dingli cliffs). The landscape comprises:

- **Rock outcrop & massive boulders.**
- **Calcaric-Endoleptic Regosols:** Carbonatic Ly colluvial drift with limestones. (on active slopes)
Ah/Cu; Cu/Ah; R at 50 to 100+ cm. (*Estimated occurrence based on observation*)
- **Endoleptic Calcisols:** Carbonatic Ly over Lithoskeletal Limestone (on 'stabilised' terraces).
Ah/Cu; Cu/Ah; Ck; R at 50 to 100+ cm. (*see profile at 4450 6760*)

5) **Bare slopes in the Blue Clay**

Very steep, severely eroded active slopes on Blue Clay, limited to small areas in Gozo (seen from the Gorban lighthouse). Deep gulleys are common in this 'badlands' landscape which preclude agriculture. Slopes are too active to allow any significant soil development and thus carry Regosols. However, it is possible that some very localised footslope areas are sufficiently stable to have developed slight 'vertic' features and 'calci' layers. The landscape thus comprises:

- **Calcaric Regosols:** Swelling clayey material passing to clay or soft mudstone.
A/C and/or Cu (*Estimated occurrence based on observation*)
- **Calci Vertisols ??:** Swelling Cy colluvial material passing to clay or soft mudstone.
A/C; 2BC(g)k; 2Cu (*Estimated occurrence based on observation*)

6) **Spring line at top of Blue Clay outcrop**

Gentle concave slopes at the foot of Coralline Limestone bluffs (landscape 3 above). These carry Luxuriant vegetation (even when seen in June 2002), and are probably

marked by gley soils. Widespread in Gozo and Kercem market gardens are probably in this landscape. The surface is locally littered with Coralline limestone blocks fallen from the overlooking bluffs. The landscape probably comprises:

- **Calcari-Stagnic Cambisols ??:** Swelling Cy material passing to clay or soft mudstone.
Ah?; A/Bg; BCg; (*Estimated occurrence based on observation*).
Is there also a 'saline version? (Stagni-Endosalic Cambisols).

7) Blown sand of Ramla valley (Gozo)

Sand dunes and associated areas of blown sand on west-facing valley slope. This landscape, only seen from a distance, appears to be deeply terraced and carry deep sandy soils (**Arenosols?**).

B. MAN MADE LANDSCAPES.

8) Moderate to steep terraces on the Blue Clay outcrop.

Narrow terraces below the Coralline limestone caps of Dingli cliffs formed in Blue Clay above the vertical Globigerina limestone sea cliffs. The terraces have received slope wash from the Coralline Limestone soils and rock outcrops above. The soils have been comprehensively affected by terracing activities, which in places, are deep enough to mask the underlying Blue Clay so that shrink-swell features typical of most clayey soils are not to be seen and the soils appear to be Calcisols rather than Vertisols. This can usually be recognised by the presence of brownish rather than olive-grey topsoil. Along the lower edge of the landscape unit may be some Endoleptic Calcisols formed in terraced material over Upper Globigerina limestone. The landscape thus comprises:

- **Calcic Vertisols:** Swelling clayey terraced material passing to clay or soft mudstone.
Ap; Bw, BC(g)k. (*see profile at 4650 6752*)
F Ly or Cy terraced material over swelling Cy material passing to clay or soft mudstone.
Ap; A/B(k) and/or 2BC(g)k (*Estimated occurrence based on observation*)
- **Hypocalcic Calcisols:** F Ly or Cy terraced material over swelling Cy material passing to clay or soft mudstone. (Brown soils in terraces created from either imported material or areas of thin slope wash from the overlying Coralline Limestone outcrop).
Ap; ABk; 2BC(g)k. (*Estimated occurrence based on observation*)
F Ly or Cy terraced material in Made Ground with limestones. (Brown soils in terraces created from thick slope wash from the overlying Coralline Limestone outcrop).
Ap; ABk. (*Estimated occurrence based on observation*)
- **Endoleptic Calcisols:** Carbonatic Ly terraced material over Lithoskeletal Limestone. (Grey soils in terraces mainly created on the lowest part of the bench where the Upper Globigerina limestone starts)
Ap; Ck; R. (*Estimated occurrence based on observation*)

9) Gentle to moderately terraced slopes on the Blue Clay outcrop.

Typical of much of landscape immediately below the limestone bluffs of Mdina, the Blue Clay inlier in the limestones west of Rabat and the Scarplands of central-northern Gozo. This landscape separates out soils formed on relatively 'pure' Blue Clay on the gentler slopes well away from the Upper Coralline rock outcrops. In these areas, although terracing activities may have affected the upper soil layers, the principal soil forming factors are: The 'dry' season development of deep cracks and 'slicken-sided' soil structures (vertic features) together with 'calcic' layers; The 'wet' season development of slight gleying in the subsoil because of rapid saturation in the dense, very slightly porous, swelling clay material. The landscape thus comprises:

- **Calcic Vertisols:** Swelling clayey terraced material passing to clay or soft mudstone.
Ap; Bw, BC(g)k. (*see profile at 4360 7175*)
F Ly or Cy terraced material over swelling Cy material passing to clay or soft mudstone.
Ap; A/B(k) and/or 2BC(g)k (*Estimated occurrence based on observation*)

10) Steep to moderate Terraces

This landscape, possibly only on Globigerina Limestone) delineates areas where terracing activities and the contemporary formation of 'calcic' layers are the dominant soil forming factors. The soils are mainly brownish with some greyish ones and the main distinctions are depth to lithoskeletal limestone and the Ca CO₃ content of the fine earth (separating 'grey' 'carbonatic' soils from 'brown' calcareous soils). Brownish Hypocalcic & Endoleptic Calcisols tend to be at the 'deep' end of the terrace or on middle slopes, with brownish Epileptic Calcisols and brownish (or greyish?) Calcari-Epileptic Regosols at the 'shallow' end or on slope brows and crests.

It may be possible to sub-divide this landscape into a 'pure greyish' class (carbonatic Epileptic Calcisols and Regosols only) and a 'mixed brownish and greyish' class (all soil types) using the ortho-photos.

At present this landscape includes:

- **Hypocalcic Calcisols:** F Ly or Cy terraced material with limestones
Ap; ABk (*see profile at 4750 6750*)
- **Endoleptic Calcisols:** F Ly or Cy terraced material over lithoskeletal limestone.
Ap; ABk; 2BC; 2R. (*see profiles at 4450 7450, 6050 6750 & the deeper profile at 4650 7450*)
- **Epileptic Calcisols:** F Ly terraced material over lithoskeletal limestone.
Ap; ABk; 2R at 35 to 50 cm. (*See profile at 6043 7033*)
- **Calcari-Epileptic Regosols:** F Ly terraced material over lithoskeletal limestone.
Ap; 2R at 25 to 35 cm. (*see the shallower profile at 4650 7450*)
Carbonatic Ly terraced material over lithoskeletal limestone.
A/Cp; Cu and/or 2R (*see profile 4650 7750*).

11) Shallow Terraces

This landscape, which is extensive on the Globigerina plateau forming the eastern part of Malta, distinguishes areas where terracing activities are likely to have affected

mainly the upper parts of the soil so that in 'deeper' parts of the terrace there may be relatively undisturbed subsoil material representing the relict reddish 'argic' horizons formed during the wetter periods of the Pleistocene. Elsewhere, these relict argic horizons have been mixed with other materials to form reddish or brownish terraced material over limestone or limestone rubble. The contemporary formation of 'calcic' layers appears to be widespread but there is at least one recorded point where this is not the case, possibly because of recent disturbance or relatively low CaCO₃ content in the soil.

The soils are mainly brownish and reddish and no greyish soils have yet been recorded. Soil depth is variable from <10cm to 1m and this is likely to reflect previous (Pleistocene?) patterns of erosion and deposition. Again, it may be possible to separate out two landscape sub-classes using the ortho-photos: A mainly reddish class with deeper soils (Endoleptic Calcisols, Luvisols and Cambisols) and a more mixed brownish and reddish class with shallower soils (mainly Epileptic Calcisols with some Epileptic Luvisols, Epileptic Regosols and Epileptic Cambisols and Leptosols - this may be mainly on the Upper Coralline?).

At present this landscape includes:

- **Endolepti-chromi-Calcic Luvisols:** (Reddish) F Ly terraced (and sometimes colluvial material over reddish clayey material over lithoskeletal limestone. Ap; ABk and/or Bwk; 2BCt'k; 3R. at 50 to 100+ cm. (*see profile at 5950 6750*).
- **Endoleptic Calcisols:** (Reddish) F Ly terraced material over lithoskeletal limestone. Ap; ABk; 2R at 50 to 100 cm. (*see profile at 4950 6750*)
- **Calcari-Endoleptic Cambisols:** (Reddish) F Ly terraced material over lithoskeletal limestone. Ap; ABw; 2R at 50 to 100 cm. (*see profile at 4750 7350*)
- **Chromi-calcic-Epileptic Luvisols:** a variety of materials (terraced Zy, F Ly & Ly skeletal) over reddish clayey material over lithoskeletal limestone. Ap; 2Bt'k and/or 2BCt'k; 3R at 25 to 50 cm. (*see profile at 4352 6950 and the deeper profile at 4250 7450*)
- **Epileptic Calcisols:** (Reddish) F Ly terraced material over lithoskeletal limestone. Ap; ABk; 2R at 35 to 50 cm. (*See profiles at 4850 7840, 4950 7852 and 5905 7111*)
- **Calcari-Epileptic Regosols:** (Reddish) Co Zy to F Ly terraced material over lithoskeletal limestone. Ap; 2R at 25 to 35 cm. (*see shallower profile at 4250 7450*)
- **Calcari Leptosols:** Reddish Ly lithoskeletal limestone. Ap; 2R at <25 cm. (*see profile at 5150 7550*)

12) Very shallow Terraces and un-terraced fields on Limestones.

This landscape distinguishes areas where terracing activities are likely to have had only a minimal effect on the soil so that below the cultivated layers the soil is largely 'in situ'. The presence of relict reddish clayey 'argic' horizons appears to be common and contemporary formation of 'calcic' layers is widespread, except where the soil is very shallow (<25cm deep). However, there may be deeper soils where calcic layers have not formed, as in landscape 10.

The soils are mainly reddish, possibly with a few brownish areas where terraced topsoil material is present. No greyish soils have yet been recorded. Soil depth is very variable from <10cm to over 1m and this is likely to reflect previous (Pleistocene?) patterns of erosion and deposition. Again, it may be possible to separate out two landscape sub-classes using the ortho-photos: A class with deeper soils (Calcic Luvisols and Endolepti-Calcic Luvisols) and a more mixed class with shallower soils (mainly Epileptic Calcisols and Leptosols, possibly with some Epileptic Luvisols - this may be on 'eroded' parts of the Lower Globigerina Limestone?).

At present this landscape includes:

- **Chromi-Calcic Luvisols:** (Reddish) Co Zy to F Ly terraced (sometimes colluvial) material over Reddish Cy Pleistocene drift with limestones. Ap, Bwk; 2Bt'k (*see profile at 5650 6850*).
- **Endolepti-chromi-Calcic Luvisols:** a variety of materials (terraced Zy, F Ly & Ly skeletal) over reddish clayey material over lithoskeletal limestone. Ap; ABk and/or Bwk; 2BCt'k; 3R. at 50 to 100+ cm. (*see reconnaissance profile at 5800 7160*).
- **Epileptic Calcisols:** (Reddish) F Ly terraced material over lithoskeletal limestone. Ap; Bwk; BCk; 2R at 40 to 100cm depth (*see profile at 4348 7450 and reconnaissance profile at 5970 6930*)
Reddish Ly lithoskeletal limestone. Ap; Apk; 2R at 15 to 35 cm. (*see profile at 5750 6750*)
- **Calcari-Lithic Leptosols:** Reddish Ly lithoskeletal limestone. Ap; 2R at <15 cm. (*see profile at 5750 6751*)

13) Very shallow Terraces and un-terraced fields on Valley fill deposits.

This landscape distinguishes areas of deep valley fill on flat valley bottoms with virtually no need of terracing. Below the cultivated layers the soil is largely 'in situ'. The soils appear to be largely colluvial in origin and are mostly derived from erosion of adjacent slopes. Upper layers commonly contain artefacts of pottery (and possibly 'imported' 'dark' stone) fragments, indicating their formation in the last 5 to 6 thousand years. Lower layers appear to be always reddish and, where they do not contain artefacts, could represent erosion and deposition during the Pleistocene wet periods. The contemporary formation of 'calcic' layers is widespread but there may be some soils where calcic layers have not formed, as in landscape 10. The main distinction between soils is likely to be those where artefacts are found to at least 1m depth (non-argic and thus Calcisols) and those where a subsoil layer with artefacts is separated from an underlying (and redder, more clayey) layer with no artefacts (argic and thus Calcic Luvisols). This boundary could often be indicated by a 'stone line'.

The landscape consists of:

- **Hypocalcic Calcisols:** Cy colluvial material over Reddish clayey colluvial drift with Limestones. Ap; ABk; 2Bwk. (*see profile at 4250 7750 & reconnaissance profile in the Pwales valley*)
- **Chromi-Calcic Luvisols:** (Reddish) F Ly, F Zy or Cy colluvial material over Reddish Cy Pleistocene drift with limestone.

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Ap; ABk and/or Bwk; 2Bt'k. (*estimated occurrence but could be profile at 4250 7750?*)



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Malta**

Inventory and classification of recorded profiles taken during the period May 27th 2002 to July 4th 2002.

Grid Reference	Geology	Landscape ²	FAO Soil Class	Series' definition
4050 7450	Upper Coralline	Garrigue	Calcaric Leptosol	Reddish Ly lithoskeletal Lst.
5550 6850	Lower Globigerina	Made Ground	Epileptic Calcisol	Reddish Ly Lithoskeletal Limestone
4950 7750	Lower Coralline	Made Ground	Spolic Regosol	Co Zy earthy material over urban waste
4360 7175	Blue Clay	Moderate terraces?	Calcic Vertisol	Swelling-Cy material passing to clay or soft mudstone
4650 6752	Blue Clay	Moderate terraces	Calcic Vertisol	Swelling-Cy material passing to clay or soft mudstone
4450 7450	Upper Coralline	Steep terraces	Endoleptic Calcisol	F Ly terraced material over lithoskeletal Lst.
4750 6750	Upper Globigerina	Steep terraces	Hypocalcic Calcisol	F Ly terraced material with Lst.s
4850 6750	Lower Globigerina	Moderate terraces	Calcari-Anthropic Regosol	Reddish Ly skeletal terraced made ground
4850 6752 (same field)			Calcari-Anthropic Regosol	F Ly terraced material over reddish Ly skeletal made ground
4650 7750	Upper Globigerina	Moderate terraces	Calcari-Epileptic Regosol	Carbonatic-Co Ly terraced material over Lithoskeletal Lst.
4650 7450 (same pit)	Middle Globigerina	Moderate terraces	Calcari-Epileptic Regosol	F Ly terraced material over lithoskeletal Lst.
4150 7450	Upper Coralline? Blue Clay ?	Moderate terraces	Endoleptic Calcisol	F Ly terraced material over lithoskeletal Lst.
6050 6750	Middle Globigerina	Moderate terraces	Endoleptic Calcisol	Cy terraced material over Reddish Co Zy material over lithoskeletal Lst.
6043 7033	Middle Globigerina	Moderate terraces	Endoleptic Calcisol	F Ly terraced material over lithoskeletal Lst
4450 6760	Lower Globigerina?	Uncultivated Moderate terraces	Endoleptic Calcisol	Carbonatic Ly? terraced material over lithoskeletal Lst.
5150 7550	Lower Globigerina	Shallow terraces	Calcaric Leptosol	Carbonatic Ly terraced material over lithoskeletal Lst.
4750 7350	Lower Globigerina	Shallow terraces	Calcari-Endoleptic	Reddish Ly Lithoskeletal Lst F Ly terraced material over lithoskeletal Lst



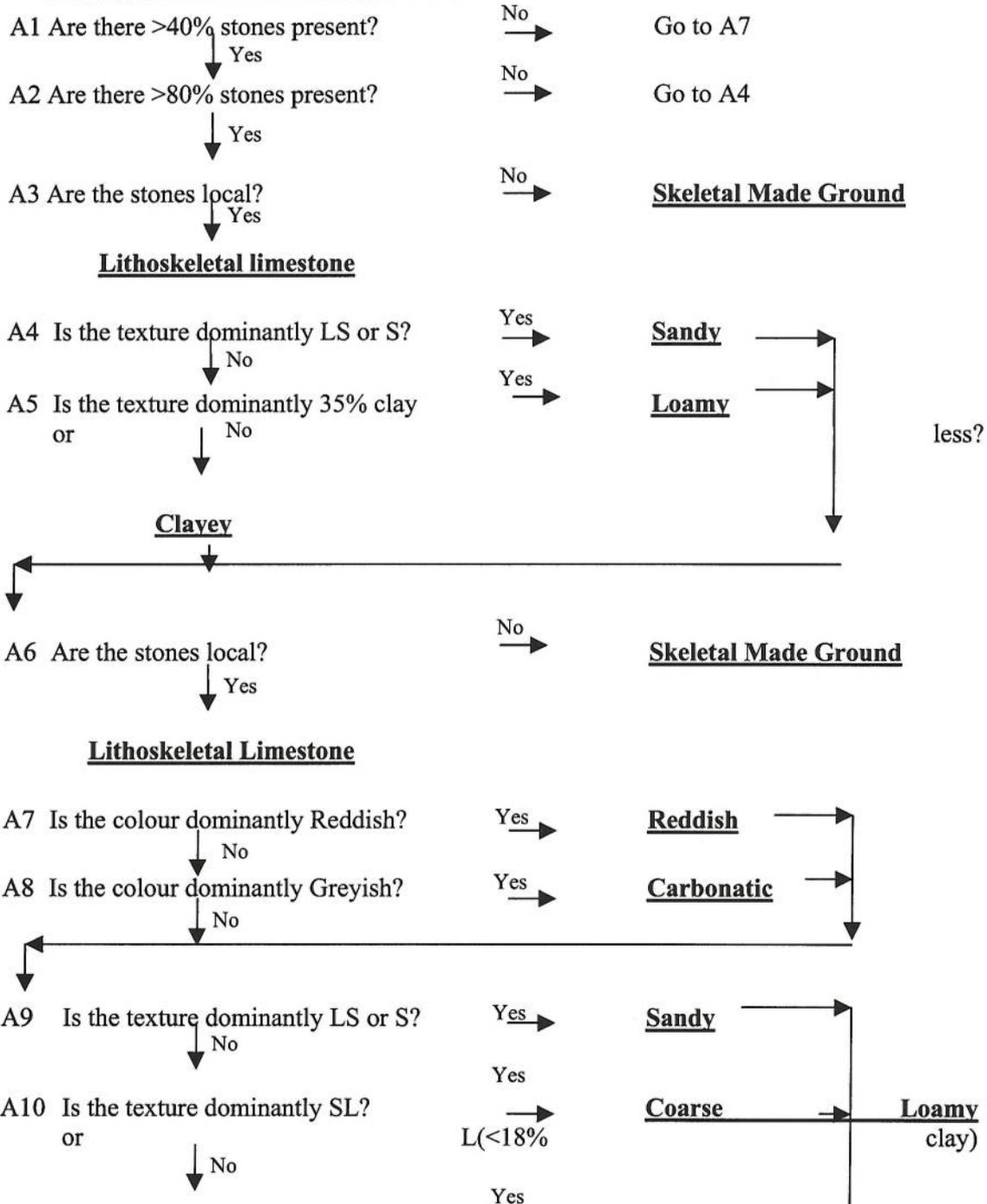
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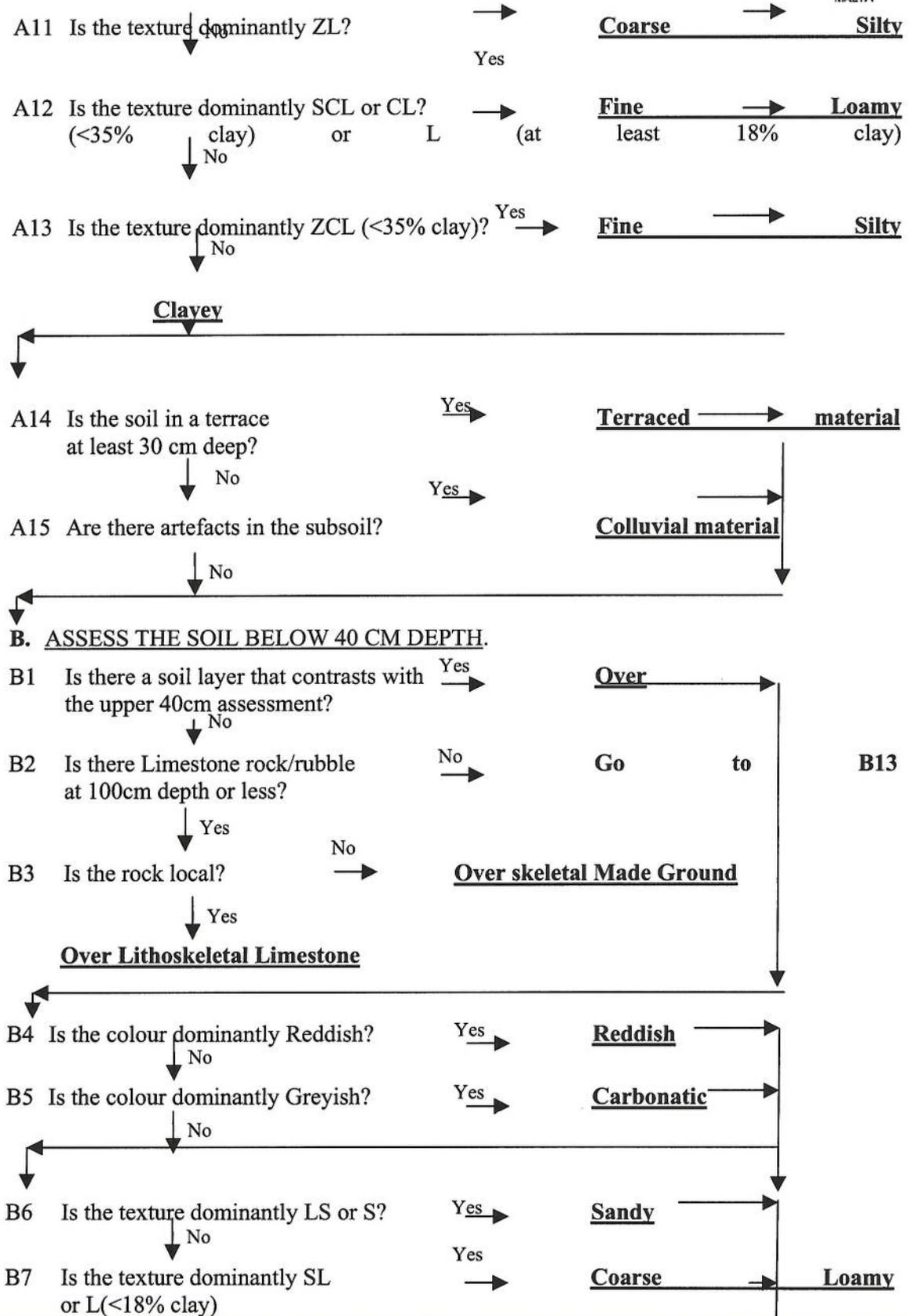
				Cambisol	
4352 6950	Upper Coralline	Shallow terraces	Chromi-calcic-Epileptic Luvisol	terraced Ly skeletal raised soil over Reddish Cy material over lithoskeletal Lst.	
4250 7450 (same pit)	Upper Coralline	Shallow terraces	Chromi-calcic-Epileptic Luvisol	Co Zy terrace material over Reddish Cy material over lithoskeletal Lst.	
4950 6750	Lower Globigerina	Shallow terraces	Calcari-Epileptic Regosol	Co. Zy terrace material over lithoskeletal Lst.	
5950 6750	Middle Globigerina	Shallow terraces	Endoleptic Calcisol	F Ly terraced material over lithoskeletal Lst.	
5905 7111	Middle Globigerina	Shallow terraces	Endolepti-chromi-Calcic Luvisol	Reddish Cy terraced colluvial material over lithoskeletal Lst.	
4850 7840	Lower Globigerina	Shallow terraces	Epileptic Calcisol	F Ly terraced material over lithoskeletal Lst.	
4950 7852	Lower Globigerina	Shallow terraces	Epileptic Calcisol	F Ly terraced material over lithoskeletal Lst	
4250 6950	Upper Coralline	Uncultivated Shallow terraces	Calcaric Leptosol	Reddish F Ly terraced material over Lithoskeletal Lst terraced Reddish Cy lithoskeletal Lst.	
5650 6850	Lower Globigerina	V. shallow terraces	Chromi-Calcic Luvisol	Reddish Co Zy terraced material over Reddish Cy Pleistocene drift with Lsts.	
5800 7160	Lower Coralline	V. Shallow terraces	Endolepti-chromi-Calcic Luvisol	F Ly terraced material over reddish Cy material over lithoskeletal Lst.	
4348 7450	Upper Coralline	V. Shallow terraces	Epileptic Calcisol?	Reddish F Ly terraced material over lithoskeletal Lst.	
5970 6930	Lower Globigerina	V. shallow terraces	Epileptic Calcisol	F Ly terraced material over lithoskeletal Lst.	
5750 6750	Lower Globigerina	Unterraced	Epileptic Calcisol	Reddish Ly lithoskeletal Lst.	
5750 6751 (same field)			Calcari-Lithic Leptosol	Reddish Ly lithoskeletal Lst	
4250 7750	Valley fill	Unterraced	Hypocalcic Calcisol	Reddish Cy colluvial drift with Lst.s	

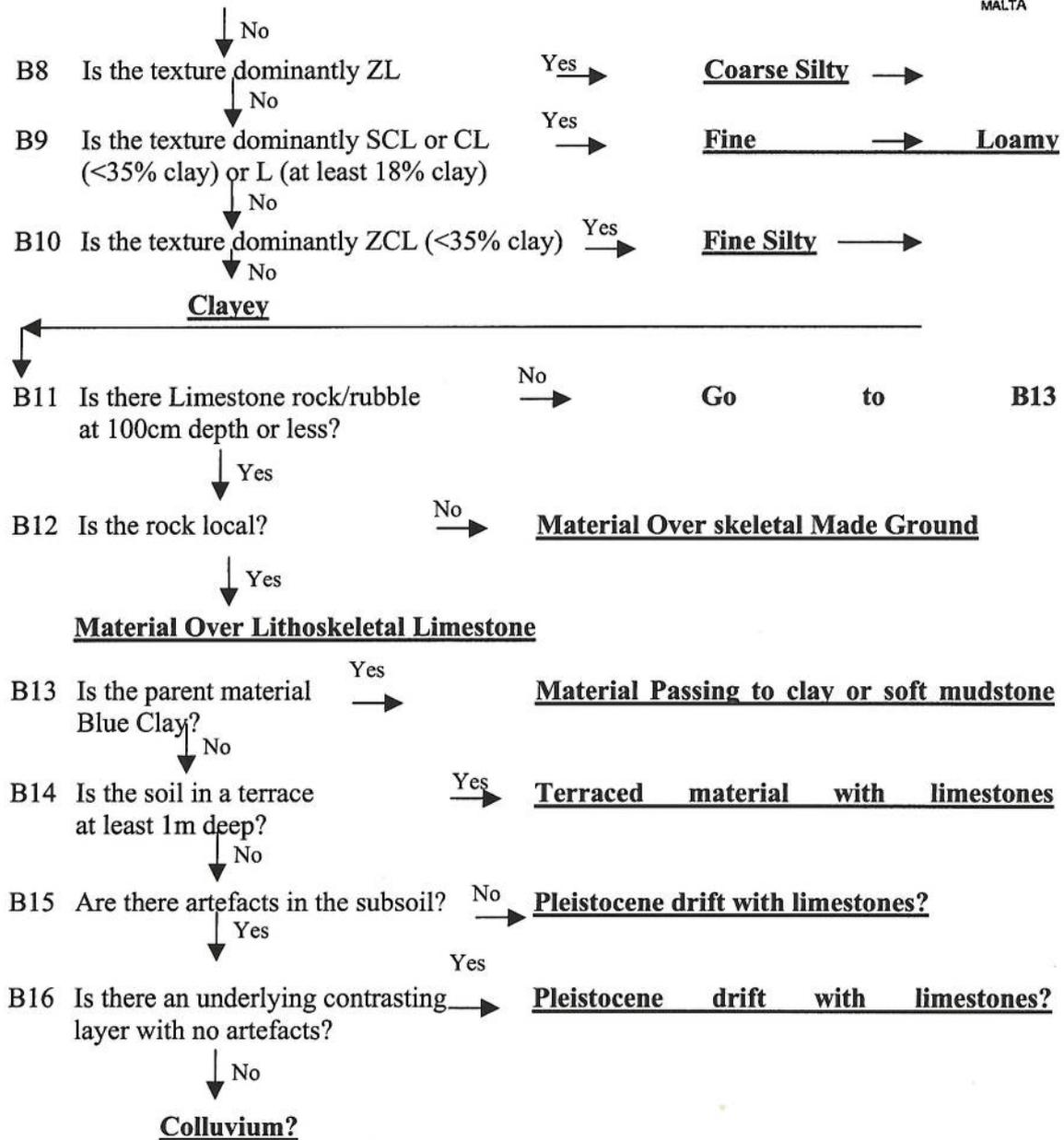
¹ I = Inventory site. ² steep terraces > 2m height; moderate terraces 1 – 2 m height; shallow terraces 1 – 0.4 m height; V. shallow terraces <0.4

7.7 Appendix 7: Texture, Mineralogy, Lithology Flow Chart

A. ASSESS THE UPPER 40 CM OF SOIL.







- Note that these flowcharts may well be developed to form a component of the ultimate soil information system

7.8 Appendix 8: Extract from MALSIS grid survey sample recording logbook

Date	Grid reference	Sample reference	Laboratory number	Sample depth	Bulk density tins (Y/N)
11-06-02	47500-67500	G274	S00189/02	H2 50-55	Y
11-06-02	46500-67520	G273	S00190/02	H2 43-48	Y
11-06-02	46500-67520	G273	S00191/02	B 0-15	N
11-06-02	47500-67500	G274	S00192/02	H1 0-5	Y
11-06-02	47500-67500	G274	S00193/02	B 0-15	N
11-06-02	46500-67520	G273	S00194/02	H1 0-5	Y
12-06-02	48500-67500	G275	S00195/02	H2 31-42	N

7.9 Appendix 9: Programme for laboratory analysis and QA training course

Laboratory Techniques Training Programme

Aims:

To provide information on the analytical procedures to be used and how the information is recorded in a format that would meet the requirements of an accreditation standard.

Objectives:

1. to provide background information on less familiar analytical procedures;
2. introduction to the requirements of Good Laboratory Practice (as an example of laboratory accreditation).

Programme 29 July – 2 August 2002 based at Silsoe, Bedfordshire:

Day 1

- Introduction to NSRI laboratory
- Sample receipt, preparation and archiving
- Introduction to GLP accreditation

Day 2

- Training records
- Environmental control and record keeping
- Control and review of SOPs
- Determination of soil organic carbon and the use of “Reagent Preparation” forms

Day 3

- Particle size distribution – pipette method *
- pH in water *

Day 4

- Cation exchange capacity *
- Calcium carbonate content *

Day 5

- Aqua regia soluble metals *

* a system of quality control should be agreed for each analytical procedure. This may be the use of reference materials and/or replication of project samples.

Daily Review:

At the end of each day, the sessions covered will be discussed and reviewed.

Program Review:

At the end of the training program the contents will be discussed

Information Sessions:

Individual sessions will consist of a mix of tutor-led instruction and hands-on practical exercises.

7.10 Appendix 10: Programme for soil information systems training course



Aim:

Enable participants to use ArcGIS (ArcView tier) effectively for their day-to-day applications, and understand the data structures underlying it.

Objectives:

- Review functionality and operation of ArcGIS
- Input data from a variety of sources
- Visualise data
- Develop rendering symbol sets
- Query and select data
- Produce reports and map outputs
- Introduce user interface customisation within ArcGIS

Intended Participants:

Scientific users who use GIS software in Malta on a day to day basis, and who require specific ArcGIS training to enable them to integrate their data and daily tasks to ArcGIS.

Day 1: Overview of ArcView

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- The ArcGIS interface. Data formats supported by ArcView. File naming conventions.
- Definition of the ArcGIS components - ArcMap, ArcCatalog, ArcToolbox.
- Features of the ArcMap document and layers to be aware of. Assigning properties to map documents. Map document components.
- What is an extension?. What is in the table of contents?
- Assigning properties to layers. Ordering layers.
- Defining legends. Layer display - zoom functions, scaling.
- Viewing attribute data. Attribute table properties.

Day 2: Data input, viewing and access

- Data structures - point, line, polygon, annotation, raster. Data translation - Map Manager, import options, export options, extensions. Conversion to shape files. Creating new data - points, polylines, polygons, graphic elements, attribute assignment. Editing existing features and attributes.
- The viewing environment. Supported data types - vector and raster products. Zoom functions. Layer selection for display. Selective viewing according to scale. Feature annotation.
- Defining common symbol sets. Marker, line, fill, colour, text. Assigning corporate symbol sets as default.
- Corporate versus locally held data. Geodatabase structure. Database table properties. Database layer properties. Managing data via ODBC/SDE.

Day 3: Data querying and case studies

- Map based query - basic query functions, complex query functions.
- European Soil Map case study. Background, structure, querying.
- JOSGIS case study. Background, structure, querying.
- NSI case study. Background, structure, querying.

Day 4: Data output and presentation

- Layout functions. Template design. View frames versus graphic objects. Legend Tool extension. Graphic types. ArcIMS.
- Seagate Crystal Reports application - report types.

Day 5: Customisation and the internet

- Changing the user interface - adding, removing, reordering menus, buttons, tools, popups. Using VBA scripts. Altering the appearance of ArcView on startup.
- Internet Mapping. Principles and examples.

Daily Review:

At the end of each day, the information sessions covered will be discussed and reviewed.

Program Review:

At the end of the training program the contents will be discussed

Information Sessions:

Individual sessions will consist of a mix of tutor-led instruction and hands-on practical exercises.



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7.11 Appendix 11: MAL SIS Relational Data Analysis

Data Dictionary and Provisional Data Structure

The following represents a provisional data dictionary (v1.4) for the databases required to store the information from the field surveys.

Table: SITE

Comment: Site Specific Details

FIELD	DATA TYPE	VALIDATION	ONSCREEN COMMENT	EXAMPLE
Site_GridRefTargetEast	Int5	>MinEastMalta (2655) <MaxEastMalta (6182)	Intended Site Easting (Metres)	4250
Site_GridRefTargetNorth	Int5	>MinNorthMalta (6275) <MaxNorthMalta (9355)	Intended Site Northing (Metres)	7750
Site_GridRefGPSNorth	Int9	>MinNorthMalta (6275) <MaxNorthMalta (9355)	GPS Recorded Site Easting (Metres)	4250
Site_GridRefTargetEast	Int9	>MinEastMalta (2655) <MaxEastMalta (6182)	GPS Recorded Site Northing (Metres)	7750
Site ProjectRefNo (*)	VarChar4	Not Null	Site and Lab Reference Number	G009
Site Observers 1	VarChar3	Pick{AAB,SPC,WMC,SJV}	Site First Surveyor	SPC
Site PASS	Int4		PA Survey Sheet Number	6091
Site Observers 2	VarChar3	Pick{AAB,SPC,WMC,SJV}	Site Second Surveyor	WMC
Site Date	Date	IsValidDate (in 2002-2003)	Date of Site Survey	140602
Site_Altitude	Float	Float 6.2 >0 <MaltaMaxAltitude (Converted to Metres)	Site Altitude (Metres)	14.63
Site Slope	Float	Float 3.1	Site Slope (percent)	
Site Aspect	Int3	<=365	Site Aspect (Compass degrees)	342
Site Form	VarChar1	Pick{S,C,V,T,X}	Site Form	S
Site_PhotoRefNorth	VarChar30		Site Photograph North File Reference	G009N.jpg
Site PhotoRefEast	VarChar30		Site Photograph East File	G009E.jpg



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Site_PhotoRefSouth	VarChar30	Reference	Reference
Site_PhotoRefWest	VarChar30	Site Photograph South File Reference	G009S.jpg
Site SketchPlanExists	Boolean	Site Photograph West File Reference	G009W.jpg
Site SketchPlanFilename	VarChar30	Sketch plan of Site present	True
Site_GridSamplingMarkExists	Boolean	Site Sketchplan Scan File Reference	G009K.jpg
Site_Inaccessible	VarChar2	Grid Sampling Pattern Annotation present	True
Site_RockOutcrop	VarChar1	Site Inaccessibility	
Site_NonAgricLandUse	VarChar2	Site Rock Outcrops	N
Site_HumanImpact	VarChar3	Site Non Agricultural Land Use	Un
Site_TerraceHeight	Int3	Site Human Impact	
Site_AgricLandUse	VarChar2	Site Terrace Height	
Site_Irrigation	VarChar2	Site Agricultural Land Use	Vn
Site_SoilSurfaceCond	VarChar10	Site Irrigation	DI
Site_SurfaceVegCover	VarChar5	Site Soil Surface Condition	Ptl Silkd
Site_ManMadeSurfaceForm	VarChar5	Site Surface Vegetation	40-80
Site_ManMadeSurfaceChannels	VarChar4	Site Man Made Surface Form	Mound
Site_ErosionDeposition	VarChar4	Site Man Made Surface Channels	N
Site_SamplesBulkTopsoil	Boolean	Site Erosion and Deposition	N
Site_SamplesHorizonTopsoil	Boolean	Bulk sample taken of Topsoil – grid	True
Site_SamplesHorizonSubsoil	Boolean	Horizon sample taken of Topsoil	True
Site_SamplesHorizonSubsoil	Boolean	Horizon sample taken of Subsoil	True

il				
Site SamplesTopsoilTins	Int2	<=4		Number of Tins – Topsoil
Site SamplesSubsoilTins	Int2	<=4		Number of Tins – Subsoil
Site FreeText	Memo	-		Site Free Text

Table: HORIZON

Comment: Horizon Specific Details for each Site

FIELD	DATA TYPE	VALIDATION	ONSCREEN COMMENT	EXAMPLE
Hor Order (*)	Int2	Not Null Autonumber		01
Hor_SiteProjectRefNo (*) (f)	Int5	Not Null		00009
Hor Depth	Int3		Horizon Depth (cm)	15
Hor_PSC	VarChar3	Pick{C,L,CL,Si,SiC,SiCL,SiL,SC,SCL,SL,LS,S}	Horizon Particle Size Class	CL
Hor %Clay	Int2	IsPercent	Horizon Percentage Clay	38
Hor %Sand	Int2	IsPercent	Horizon Percentage Sand	22
Hor StructureGrade	VarChar2	Pick{VW,WE,MO,ST,VS}	Horizon Structure Grade	MO
Hor StructureSize	VarChar2	Pick{VF,FI,ME,CO,VC}	Horizon Structure Size	FI
Hor StructureShape	VarChar2	Pick{PL,PR,AB,SB,GR}	Horizon Structure Shape	SB
Hor_HorizonNomenclature	VarChar7		Horizon Nomenclature	_Ap1__
Hor StoneAb	VarChar1	Pick{N,V,F,C,M,A,D}	Horizon Stone Abundance	N
Hor StoneSize_1	VarChar1	Pick{F,M,C,S,B,L}	Horizon Stone Size 1	M
Hor StoneSize_2	VarChar1	Pick{F,M,C,S,B,L} If Hor StoneSize_1 NOT NULL	Horizon Stone Size 2	C
Hor StoneNature	VarChar2	Pick{L,N}	Horizon Stone Nature	L
Hor NoduleNature	VarChar2		Horizon Nodule Nature	
Hor NoduleAb	VarChar1	Pick{N,V,F,C,M,A,D}	Horizon Nodule	N

Hor_RootsAb	VarChar1	Pick{N,V,F,C,M}	Abundance	Horizon	Roots	V			
Hor_RootsSize	VarChar2	Pick{VF,F,M,C}	Horizon Roots Size	Horizon Roots Size		F			
Hor_RootsNature	VarChar3	Pick{Wdy,Fbr,Fsh}	Horizon Roots Nature	Horizon Roots Nature		Wdy			
Hor_Moisture	VarChar5	Pick{dry,s mst,mst,v mst}	Horizon Moisture	Horizon Moisture		mst			
Hor_Matrix	VarChar6	Picture{99AA99}	Horizon Matrix	Horizon Matrix		75YR34			
Hor_Mottle	VarChar6		Horizon Mottle	Horizon Mottle					
Hor_MottleAb	VarChar1	Pick{N,V,F,C,M,A}	Horizon	Horizon	Mottle	N			
Hor_MottleSize	VarChar2	Pick{V,F,Md,C,Ma,A}	Abundance	Abundance					
Hor_Penetration	Float	Float 2.1	Horizon Mottle Size (cm)	Horizon Mottle Size (cm)					
Hor_Penetration>4_5	Boolean	[Default: False]	Horizon Penetration (cm)	Horizon Penetration (cm)		2.0			
Hor_MoistColour	VarChar6	Picture{99AA99}	Horizon Penetration > 4.5 cm	Horizon Penetration > 4.5 cm		False			
Hor_Mottle2	VarChar6		Horizon Moist Rubbed Colour	Horizon Moist Rubbed Colour		75YR34			
Hor_Mottle2Ab	VarChar1	Pick{N,V,F,C,M,A}	Horizon Mottle 2	Horizon Mottle 2					
Hor_Mottle2Size	VarChar2	Pick{V,F,Md,C,Ma,A}	Horizon Mottle 2 Abundance	Horizon Mottle 2 Abundance					
Hor_BoundaryForm	VarChar1	Pick{A,G,C,D}	Horizon Mottle 2 Size (cm)	Horizon Mottle 2 Size (cm)					
Hor_Artefacts	Boolean		Horizon Boundary Form	Horizon Boundary Form		A			
Hor_Shape	VarChar2	Pick{S,W,I,B}	Horizon Artefacts	Horizon Artefacts		Y			
Hor_FreeText	Memo	-	Horizon Shape	Horizon Shape		W			
			Horizon Free Text	Horizon Free Text		Structure breaks to fine granular			

Table: PICKLIST
Comment: Selection Picklists for on-screen data entry

FIELD	DATA TYPE	CONTENTS
Site Observers 1	VarChar3	{AAB,SPC,WMC,SJV}
Site Observers 2	VarChar3	{AAB,SPC,WMC,SJV}
Site Form	VarChar1	{S,C,V,T,X}
Site Inaccessible	VarChar2	{As,Cn,Bd,Fb,Gh,Ar,Es,Ht,Wt,Br,Qr}
Site RockOutcrop	VarChar1	{N,V,F,C,M,A,D}
Site NonAgricLandUse	VarChar2	{Wd,Ga,Ma,St,Ab}
Site_HumanImpact	VarChar3	{Un,MG,Te,DC,Dr,DpL,DpNL,TrM,TrW,DrV,Bu}
Site AgricLandUse	VarChar2	{Fw,Cr,Pt,Tm,Wm,Vg,Fd,Sc,Fl,Co,OI,Ft,Vn}
Site Irrigation	VarChar2	{NI,IU,SI,DI,CI}
Site_SoilSurfaceCond	VarChar10	{Furrd,Mound,Fltnd,Unslk,Ptl Silkd,Silkd,Ptl Capd,Capd}
Site Surface VegCover	VarChar5	{0,0-15,15-40,40-80,>80}
Site_ManMadeSurfaceForm	VarChar5	{Furrd,Mound,Fltnd}
Site_ManMadeSurfaceChannels	VarChar4	{VWX,VWUD,RFX,RFUD,0}
Site ErosionDeposition	VarChar4	{GR,ShE,WE,ExD,MnD,0}
Hor_PSC	VarChar3	{C,L,CL,Si,SiC,SiCL,SIL,SC,SCL,SL,LS,S}
Hor StructureGrade	VarChar2	{VW,WE,MO,ST,VS}
Hor StructureSize	VarChar2	{VF,FLME,CO,VC}
Hor StructureShape	VarChar2	{PL,PR,AB,SB,GR}
Hor StoneAb	VarChar1	{N,V,F,C,M,A,D}
Hor StoneSize 1	VarChar1	{F,M,C,S,B,L}
Hor StoneSize 2	VarChar1	{F,M,C,S,B,L}
Hor NoduleAb	VarChar1	{N,V,F,C,M,A,D}
Hor StoneNature	VarChar2	{L,N}

Hor_RootsAb	VarChar1	{N,V,F,C,M}
Hor_RootsSize	VarChar2	{VF,F,M,C}
Hor_RootsNature	VarChar3	{Wdy,Fbr,Fsh}
Hor_Moisture	VarChar5	{dry,s mst,mst,v mst}
Hor_MottleAb	VarChar1	{N,V,F,C,M,A}
Hor_MottleSize	VarChar2	{V,F,Md,C,Ma,A}
Hor_Mottle2Ab	VarChar1	{N,V,F,C,M,A}
Hor_Mottle2Size	VarChar2	{V,F,Md,C,Ma,A}
Hor_BoundaryForm	VarChar1	{A,G,C,D}
Hor_Shape	VarChar2	{S,W,I,B}

(*) Primary Key

(f) Foreign Key

Note:

- A Four figure grid reference, eg. 4250, 7750 is precise to within 10metres. This is considered adequate for field sheet recording.
- The Picklist table will be accessed directly by binding the onscreen drop down selection boxes to the fields within.
- Hor_StructureGrade and Hor_StructureSize can have multiple choices

7.12 Appendix 12: IT Hardware and software ordered for MAL SIS project

Item	Description	Quantity
Server	Fujitsu Siemens Dual Xeon Server H250 24 LTO Ultrium Tapes	1
PDA	HP Jornada 568 complete with Targus keyboard, USB Cradle, battery rechargeable, leather case and power adapter	2
PC	Horizon High Performance Computer System Intel P4 Harddisk 80GB	3
Notepad	DURNOTE 5600P Intel Pentium 4	1
Digital camera	Powershot S40	1
Colour printer	Minolta colour laser printer Magiccolour 2200 A3 colour inkjet HP 1220 C	1 1
UPS	850VA Off-line with surge protector	3

7.13 Appendix 13: Malta National Soil Unit 2003 – 2005 Business plan

Executive Summary

Soil and nutrient management are key to a profitable and sustainable rural sector founded on sustainable methods of crop production and environmental management. This plan details the budget for a three year programme of work (2003 – 2005) covering the Ministry's integrated soil and nutrient work programme to be carried out by the Agricultural Chemistry Laboratory at Ghammeiri (Leader Ms Sonya Vella). The proposed work programme is specifically designed to contribute to the new overall vision for MAF. It is proposed, as a consequence of the EU Life MALSIS project that this facility be named the Malta National Soil Unit (NSU).

Agreement to investment in new staff is sought. Limited new laboratory and office floor space is sought. Requests for new capital equipment are focused on upgrading existing facilities and complimenting analytical capability. Recurrent costs will increase in line with a major expansion in field trial and demonstration projects to elaborate and the promote best nutrient and agricultural practice for the key cropping systems.

Technical and collaborative links with other European and Mediterranean institutes will be developed to make best use of available knowledge and expertise from other countries with similar climates, soils and agricultural practices.

Background

The Agricultural Chemistry Laboratory (ACL) is responsible for performing chemical analysis of agricultural materials (soil, irrigation water, and feeds) and for providing extension services and policy support in soil use and quality. This is achieved through field sampling and data collection, monitoring projects and participation in dissemination of information activities. The client base of the ACL consists of farmers and growers and to a lesser extent, private garden owners, landscape managers and entrepreneurs in agro-industry. The laboratory processes an average of 600 samples of agricultural materials on an annual basis. At present, the staff compliment of the ACL is made up of a principal scientific officer (research and development), two agricultural officers, a laboratory technician and a clerk. The current set up of the ACL incorporates office facilities and laboratory instruments used for soil survey and analytical chemistry.

As a result of the growing activities of the ACL, the existing facilities are not sufficient to meet requirements. The floor space allocated to the unit needs to be enlarged to meet laboratory design requirements, and the existing infrastructure needs to be upgraded to provide a better electricity supply, and to install fire and safety features, ventilation/extraction devices, back-up facilities, soil/paper archives and storage for chemicals.

Future Objectives

The NSU is a centre of expertise on soil resources and related issues such as diffuse pollution of groundwater within MAF. A number of factors will influence the future activities of the NSU:

- MAF's future vision for the sustainable development of rural Malta will rely on development of its technical capability in integrated soil and water management in order that crop and livestock production is efficient and competitive and has minimum impact on the environment.
- Malta's Rural Development Plan will contain agri-environmental measures that seek to minimise the environmental impact of farming practices. The conservation of soils through erosion control and anti-desertification measures and the training of growers in better nutrient management are likely to be eligible activities under the programme. The RDP proposes that the Government has a key role as a major landowner to promote these and other practices.
- The MALSIS project is an incentive for MAF to create a sustainable unit focused on characterisation of the soil resources of the Islands.
- EU accession will oblige Malta to put in place the necessary facilities to control and/or reduce the environmental impacts of agriculture. These include nitrate (the Action Programme for the Nitrate Directive has yet to be drafted), phosphorus, pesticides and veterinary products (Water Framework and Groundwater Directives), sewage (Sludge use in Agriculture Directive). Other Directives such as those relating to Environmental Impact Assessment, Integrated Pollution Prevention and Control, Waste and Composting have a bearing on the quality and protection of soil resources.

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- EU accession would oblige Malta to comply with future soil protection legislation. The current Communication on Soil Protection provides a guide to the likely obligations – soil monitoring, soil erosion and desertification controls, prevention of further soil contamination and clean up of contaminated land.
- Malta's farming community requires better technical support and advice if it is to achieve best practice in fertiliser use and soil management, to increase its competitive position and to diversify its activities under the Rural Development Plan.
- Membership of the European Union will create a need for Malta to identify a lead authority on soil resources to act as 'correspondent' within the European soil science community. Sonya Vella is already recognised by the European Soil Bureau as that contact point.
- Over and above these specific issues, the principles of sustainable development as laid out in the Sixth Environmental Action Plan and Agenda 21 will place a growing obligation on Malta to optimise the sustainable management and conservation of its soil resources.

With the above in mind, it is proposed that the NSU be equipped and focused on the performance of two fundamental future roles relating to the management and protection of soil resources that can be broken down into 17 specific activities. It may be sensible for a further activity, the registration of soil movements under the Fertile Soils Act, to be brought into the NSU but this is not included in Table 1 as it is currently catered for by a separate group within the Ministry (Land and Water).

Table 1 Future activities of the National Soil Unit

<i>Role</i>	<i>Principle activities</i>	<i>Drivers</i>
A - To act as the National Expert Group on Soil Resources		
	Soil resource survey	MALSIS project; EU Communication on Soil Protection and other Directives such as the Water Framework Directive and Groundwater Directive
	Soil information system development and management	
	Soil analysis	
	Maintenance of soil sample archive	
	Monitoring of soil quality	
	Provision of expert advice	
	Research and development	
	Provision of soil conservation services	
	Monitoring of 'receiving soils' under Sludge Use in Agriculture regulations	Sludge Use in Agriculture Directive
	International liaison	EU accession; greater programme efficiency
B - To develop as a Soil and Plant Nutrition Technical Service group		
	Drafting and promotion of the Action Programme for the Nitrate Directive	EU Nitrate Directive
	Research and development including field and laboratory trials	EU Nitrate Directive, MAF policy on technical assistance to growers
	Soil sampling and nutrient analysis	
	1. Expert advice to growers	
	2. Development, promotion (nutrient management only) and implementation (nutrient management only) of Code of Good Agricultural Practice	
	3. Management of fertiliser and soil management demonstration projects	
	4. Surveys of fertiliser use	

In order to achieve these aims, the following objectives have been identified.

Table 2 Objectives for the National Soil Unit

	<i>Objective</i>	<i>Activities</i>	<i>Target</i>
1.	Establish a fully-manned and resourced National Soil Unit	All A & B	2004
2.	Establish NSU as member of European Soil Bureau and MALSIS as EUSIS Pilot Area	A10	2002

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3.	Launch Code of Good Agricultural Practice	B5	2002
4.	Plan, agree and initiate a) soil resources and b) nutrient management research and development programmes (10 year programmes)	A7 B2	2004
5.	Complete MALSIS system (EU Life phase) and publish a report on Malta's Soil Resources	A1-4	2004
6.	Publish final version of Action Programme for Nitrate Directive (will involve initial Consultation Draft and negotiations with CEC)	B1	2004
7.	Launch improved and enhanced soil sampling, analysis and advisory service to growers	B3-4	2003
8.	Publish first (triennial) Survey of Fertiliser Use	B7	2004
9.	Establish and launch network of fertiliser and manure management demonstration farms linked to good practice promotional programmes (RDP)	B5-6	2005
10.	Publish Fertiliser Recommendations Handbook	B2-6	2005+
11.	Develop institution links within EU and Mediterranean region	A11	2003 - 5

	Objective	Deadlines		
		In 2003	In 2004	In 2005
1.	Establish a fully-manned and resourced National Soil Unit (staged)			
2.	Establish NSU as member of European Soil Bureau and MALSIS as EUSIS Pilot Area			
3.	Launch Code of Good Agricultural Practice			
4.	Plan, agree and initiate a) soil resources and b) nutrient management research and development programmes (10 year programmes)			
5.	Complete MALSIS system (EU Life phase) and publish a report on Malta's Soil Resources			
6.	Publication of the Action Programme			
7.	Launch soil sampling, analysis and advisory service to growers			
8.	Publish first (triennial) Survey of Fertiliser Use			
9.	Establish and launch network of fertiliser and manure management demonstration farms linked to good practice promotional programme			
10.	Establish a computerised Public Record of Soil Movements			
11.	Publish Fertiliser Recommendations Handbook			
12.	Develop institution links within EU and Mediterranean region			

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Achievement of the objectives

The stated activities and objectives of the NSU are interlinked and require some expansion of the current capability and expertise within the Agricultural Chemistry Laboratory to include:

the phased recruitment of additional staff to enable the business plan to be achieved,
additional space within the building currently occupied by the Agricultural Chemistry Laboratory for sample reception and preparation and additional office space,
limited purchases of equipment

To manage the proposed work programme, the NSU will require the following manpower:

Staff title	2002 (existing)	2003	2004	2005
Chief Scientific Officer				1
Principal Scientific Officer	1	1	1	2
Scientific Officers				
Nutrient management		1	1	1
Analytical chemistry		1	1	2
Spatial information systems		1	1	1
Senior Agricultural Officers				
Soil survey		1	1	1
Soil analysis		1	1	1
<i>Agricultural Officers</i>	2		2	2
<i>Senior Technicians</i>	1	1	1	1
Assistant Principal			1	1

The following capital and recurrent expenditure (all figures LM*1000) will be needed to undertake the proposed programme of work.

Item	2003	2004	2005
Capital			
Laboratory instruments (auto-analysers, micro-digerstor, fume cupboards, hydride generator)	35	10	5
Field equipment (run-off traps, nitrate suction sampler kits, etc)	10	5	2
Recurrent			
Staff recruitment	37	52	66
Staff training	25	10	5
Laboratory and field consumables	2	5	2
Sub-contracting (organic compounds)	-	-	10
TOTAL (CAPITAL)	45	15	7
Total (recurrent)	64	67	83

7.14 Appendix 14: MALSIS National Team

The table below presents the project roles for the MALSIS project

Project Roles
Technical Project Director
Advisor to Technical Director: Field Survey Component
Advisor to Technical Director: Laboratory Analysis and QA Component
Project Manager
Technical Field Staff Member
Technical Laboratory Staff Member
Technical Information Systems Staff Member
Project Facilitator
Financial Controller
Administrator
“Member of the MALSIS Project Team”

The table below identifies the staff members allocated to the project roles for the MALSIS project.

Staff Member	Project Role
George Carbone	Technical Project Director
Victor Farrugia	Advisor to Technical Director: Laboratory Analysis and QA Component
Anthony Meli	Advisor to Technical Director: Field Survey Component
Sonya Vella	Project Manager
Randall Caruana	Technical Information Systems Staff Member
Moira Bonello	Technical Laboratory Staff Member
Stefan Farrugia	Technical Information Systems Staff Member
Josephine Engelbert	Project Facilitator
Sharlo Camilleri	Technical Field Staff Member Technical Information Systems Staff Member
Anthony Borg	Technical Field Staff Member
Luciano Chetcuti	Financial Controller
Michael Sciberras	Technical Laboratory Staff Member Technical Information Systems Staff Member
William Camilleri	Technical Field Staff Member Technical Laboratory Staff Member
Kirsty Galea	Administrator

7.15 Appendix 15: Job Descriptions of MALSIS team members

MALSIS PROJECT ROLE: TECHNICAL FIELD STAFF MEMBER

RESPONSIBILITIES

- The Technical Field Staff Member has overall responsibility for undertaking the field survey component of the ongoing project activities of MALSIS.

SPECIFIC TASKS

- Be responsible for assisting the MALSIS project external advisers in reconnaissance survey missions.
- Be responsible for carrying out the national field survey, consisting of a grid survey at 1x1 km grid, a free survey and a detailed local site investigation survey.
- Be responsible for sampling soil from two depths from 400 survey locations.
- Be responsible for describing and recording the site and characteristics for each survey location.
- Be responsible for carrying out on-site soil characterisation field techniques.
- Be responsible for ensuring that collected samples are adequately labelled and stored while in transit to the laboratory.
- Be responsible for data entry of survey site characteristics and field measured soil parameters.

REQUIREMENTS

- Navigation skills
- Field survey skills
- Communication skills
- Be a “Member of the MALSIS Project Team”

DIRECTION FROM
Project Manager

DIRECTION TO
As directed by Project Manager

ANTICIPATED INPUTS AND SCHEDULE

The Technical Field Staff Member is expected to contribute up to 175 working days to the MALSIS project. This input will be carefully monitored by the Project Director and Project Manager and is subject to review every six months, depending on the actual performance of each staff member.

**Appendix 16: FINANCIAL STATEMENT OF
EXPENDITURE**

STANDARD STATEMENT OF EXPENDITURES AND INCOME

(cover note)

Project n°: LIFE 00 TCY/M/036

Project title: MALSIS, A SOIL INFORMATION SYSTEM FOR THE MALTESE ISLANDS

Full name of the Beneficiary: Ministry of Agriculture and Fisheries

Address: Barriera Wharf, Valletta CMR02 Malta

Financial form submitted for¹: INFORMATION ✓
PAYMENT

If this financial form is submitted for payment, please complete the following:

Type of payment requested: ! Advance
! First
! Final

Banking details:

Name and address of the bank:
.....

Bank account n°:

Sorting code:

Bank account holder²:

Payment reference (if necessary):

Name of legal/statutory representative: George E. Carbone

Title: Director General (Agricultural Services & Rural Development)

Function: Technical Director

Date: 27th September 2002

Signature:

¹ Oblig

BENEFICIARY'S CERTIFICATE

PROJECT N° LIFE 00 TCY/M/036

BENEFICIARY: MINISTRY OF AGRICULTURE & FISHERIES

TITLE: MAL SIS, A SOIL INFORMATION SYSTEM FOR THE MALTESE ISLANDS

We certify that the above costs were incurred in the framework of the work defined in the project and that they were necessary for the good execution of this work, that such costs have been incurred and fall within the definition of allowable costs specified, and that any necessary permissions of the Commission have been obtained.

Date: 27th September 2002

Date: 27th September 2002

Name of Project Manager³:

Name legal/statutory representative:

Sonya J. Vella

George E. Carbone

Signature of Project Manager:

Signature:

ONLY FOR LIFE-NATURE PROJECTS

We certify that the durable equipment purchased/manufactured for the project, during the project period and for which the life-expectancy is longer than that of the project, will in future be used exclusively for nature conservation activities⁴.

We certify that the necessary measure have or will be taken to ensure the maintenance of these goods for all their expected life. The life expectancy has been calculated as follows:

Infrastructures: xxx ⁵ years from purchase date

Equipment: xxx ⁵ years from purchase date

We also certify that land purchase in the framework of the project has been definitively assigned to nature conservation activities.

Signature of Project Manager:

Signature of legal/statutory representative:

³ The person designated as being directly responsible for the execution of the project.

⁴ Failing such an agreement, the depreciation rules as foreseen in the LIFE standard administrative provisions will be applicable.

⁵ Please complete with the appropriate figure, depending from the tax and accounting rules applicable in your case.

PROJECT CONSOLIDATED STATEMENT OF EXPENDITURE

TO BE COMPLETED BY THE BENEFICIARY IN THE CASE OF PARTNERSHIP

Project n°:

Title:

Full name of beneficiary:

Reference period:

Categories of expenditure ⁶	Total amount without VAT €		Total amount with non-recoverable VAT ⁷ €	
1. Personnel				
2. Travel				
3. External assistance				
4. Durable goods:	<i>Real cost</i>	<i>Eligible cost⁸</i>	<i>Real cost</i>	<i>Eligible cost⁸</i>
Infrastructure				
Equipment				
Prototype				
<i>Sub-total</i>				
5. Dissemination				
5.1 Personnel				
5.2 Travel Expenses				
5.3 External Assistance				
5.4 Consumables				
5.5 Other costs				
5.6 Overheads				
6. Consumable material				
7. Other costs				
8. Overheads				
TOTAL	<i>Real cost</i>	<i>Eligible cost</i>	<i>Real cost</i>	<i>Eligible cost</i>

Name of project manager:

Function:

Address:

Date:

Signature:

⁶ This consolidated table will reflect and sum the summary sheets provided by each of the participants [beneficiary and partner(s)] and will be the total expenditure actually incurred for the implementation of the project.

⁷ To be completed only if the beneficiary/partners have provided proof that VAT is not recoverable and therefore should be regarded as an eligible cost.

⁸ To be completed only if applicable (see art. 21.7 of the Standard Administrative Provisions)

PROJECT STATEMENT OF INCOME

PROJECT N°: LIFE 00 TCY/M/036

TO BE COMPLETED BY THE BENEFICIARY

Reference period from (dd/mm/yy) 01/03/02 to (dd/mm/yy) 31/08/02

	TYPE OF INCOME	€
1.	LIFE CONTRIBUTION RECEIVED	151,200
2.	PARTICIPANT CONTRIBUTION (beneficiary + partners) ⁹	151,200
3.	OTHER SOURCES OF FUNDING RECEIVED (please specify name of co-financing organization(s) and amount(s))	0
4.	INTEREST ACCRUED ON THE AMOUNTS RECEIVED FROM EC.	0
5.	PROFITS GENERATED BY THE PROJECT (please specify)	0
	TOTAL	302,400

⁹ The beneficiary and the partners are expected to bear part of the project costs (auto financing). Please, enter here the total amount paid so far as beneficiary/partners share of the total project costs.

**PARTICIPANT STATEMENT OF EXPENDITURE TO BE COMPLETED
FOR EACH PARTICIPANT (Beneficiary and partners)**

Project n°: LIFE 00 TCY/M/036
Project title: MALSIS, A SOIL INFORMATION SYSTEM FOR THE MALTESE ISLANDS
Full name of participant: Ministry of Agriculture & Fisheries
Short name: MAF
Status: Beneficiary ✓ Partner
Address: Barriera Wharf, Valletta CMR02 Malta

Categories of expenditure ¹⁰	Total amount without VAT €		Total amount with non-recoverable VAT ¹¹ €	
	<i>Real cost</i>	<i>Eligible cost⁸</i>	<i>Real cost</i>	<i>Eligible cost¹²</i>
1. Personnel			23,617.50	
2. Travel			6,899.50	
3. External assistance			51,900.00	
4. Durable goods:				
Infrastructure			0	0
Equipment			1010.60	505.30
Prototype			1454.00	
<i>Sub-total</i>			2464.60	1959.30
5. Dissemination				
5.1 Personnel			0	
5.2 Travel Expenses			22,797.00	
5.3 External Assistance			18,100.00	
5.4 Consumables			0	
5.5 Other costs			930.00	
5.6 Overheads				
6. Consumable material			1,488.00	
7. Other costs			0	
8. Overheads			658.50	
TOTAL	<i>Real cost</i>	<i>Eligible cost</i>	<i>Real cost</i>	<i>Eligible cost</i>
			131,319.70	130,309.10

¹⁰ This consolidated table will reflect and sum the summary sheets provided by each of the participants [beneficiary and partner(s)] and will be the total expenditure actually incurred for the implementation of the project.

¹¹ To be completed only if the beneficiary/partners have provided proof that VAT is not recoverable and therefore should be regarded as an eligible cost.

⁸ To be completed only if applicable (see art. 21.7 of the Standard Administrative Provisions)

- VAT Not recoverable:
DATE: 27th September 2002

PROOF SUBMITTED

TO BE COMPLETED FOR EACH PARTICIPANT (BENEFICIARY AND PARTNERS)

1. PERSONNEL¹²

**SHORT NAME OF PARTICIPANT: M
PROJECT N°: LIFE 00 TCY/M/036**

Name	Category in the project	Time Unit (please precise day/month/hour per year) ¹³	Time Unit rate ¹⁴ (a) €	Number of Time Unit assigned to the project (b)	Total (a x b) €
Mr George Carbone	Project Director	Man-Day	80	35.5	2,840.00
Ms Sonya Vella	Project Manager	Man-Day	55	111.5	6,132.50
Mr Randall Caruana	Technical Staff	Man-Day	50	6.5	325.00
Ms Moira Bonello	Technical Staff	Man-Day	50	6.9	345.00
Mr Sharlo Camilleri	Technical Staff	Man-Day	50	77.1	3,855.00
Mr Stefan Farrugia	Technical Staff	Man-Day	50	12	600.00
Mr Luciano Chetcuti	Support Staff	Man-Day	45	34	1,530.00
Ms Kirsty Galea	Support Staff	Man-Day	45	19	855.00
Mr Anthony Borg	Support Staff	Man-Day	45	17.5	787.50
Mr Michael Sciberras	Support Staff	Man-Day	45	21	945.00
Mr William Camilleri	Support Staff	Man-Day	45	56.5	2,542.50
Ms Josephine Engelbert	Project Facilitator	Man-Day	65	36	2,340.00
Mr Anthony Meli	Adviser	Man-Day	65	8	520.00
Mr Victor Farrugia	Adviser	Man-Day	65	0	0

TOTAL 23,617.50

¹² Personnel costs only comprise the cost of personnel directly involved in the implementation of the project.

¹³ Use the same time unit as in the project proposal for all partners.

¹⁴ Including social charges and exclusive of any other costs.

2. TRAVEL¹⁵

SHORT NAME OF PARTICIPANT: MAF

PROJECT N°: LIFE 00 TCY/M/036

Purpose of travel	Date of travel (dd/mm/yy)	Date of EC approval (if applic.)	Location (town, country)	Names of persons travelling	Invoice/ receipt (if applicable)		Date of payment (dd/mm/yy)	Total without VAT €	Total with non recoverable VAT ¹⁶ €
					N°	Date (dd/mm/ yy)			
Travel: Project Planning Mission	21 st to 24 th April 2002	NA	Silsoe, U.K.	Ms Sonya Vella	6816		30 th May 2002	260.00	
Subsistence: Project Planning Mission	21 st to 24 th April 2002	NA	Silsoe, U.K.	Ms Sonya Vella	N/A (subsistence allowance)		18 th April 2002	1,002.50	
Subsistence: Field Survey Planning Mission	8 th to 11 th May 2002	NA	Silsoe, U.K.	Mr Anthony Meli	N/A (subsistence allowance)		6 th May 2002	765.00	
Hire of 4-wheel drive vehicle for fieldwork	01 st May – 31 st August 2002	NA	Malta Gozo	Mr Sharlo Camilleri Mr Anthony Borg Mr William Camilleri				4,494.00	
Subsistence to field workers within project area					42343			138.00	
Subsistence to field workers within project area					42831			99.00	
Subsistence to field					4602			91.00	

¹⁵ It is advised to sort this table by date of payment.

¹⁶ To be completed only if the beneficiary/partners have provided proof that VAT is not recoverable and therefore should be regarded as an eligible cost.

4. DURABLE GOODS

SHORT NAME OF PARTICIPANT: MAF

PROJECT N°: LIFE 00 TCYM/036

4.3. Prototype*

(only for LIFE-Environment and LIFE Third Countries project)

Invoice/receipt		Date of payment (dd/mm/yy)	Supplier	Description	Total without VAT €	Total with non recoverable VAT ²⁶ €
N°	Date (dd/mm/yy)					
9435	04/07/02	08/07/02	Associated Supplies Ltd	Constant environmental conditions controlled chamber (soil archive): Dehumidifiers		656.00
217096	03/07/02	08/07/02	Bonnici Stores Ltd	Constant environmental conditions controlled chamber (soil archive): Extractor Fan		200.00
88745	18/07/02	25/07/02	Saviour Magro	Constant environmental conditions controlled chamber (soil archive): Ironmongery Items		282.00
HQ 326	26/07/02	07/08/02	Multipackaging Ltd	Constant environmental conditions controlled chamber (soil archive): Labelled sample boxes		283.00
18787	16/08/02	23/08/02	Joseph Caruana & Co. Ltd	Constant environmental conditions controlled chamber (soil archive): Wood material		33.00

TOTAL	1,454.00
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²⁵

To be completed only if the beneficiary/partner has provided proof that VAT is not recoverable and therefore should be regarded as an eligible cost.

²⁶

To be completed only if the beneficiary/partner has provided proof that VAT is not recoverable and therefore should be regarded as an eligible cost.

5. DISSEMINATION (only for LIFE-TCY)

SHORT NAME OF PARTICIPANT: MAF

PROJECT N°: LIFE 00 TCY/M/036

5.2 Travel expenses³⁰

Purpose of travel	Date of travel (dd/mm/yy)	Date of EC approval (if applic.)	Location (town, country)	Names of persons travelling	Invoice/ receipt (if applicable)		Date of payment (dd/mm/yy)	Total without VAT €	Total with non recoverable VAT ³¹ €
					N°	Date (dd/m m/yy)			
Training: Soil sampling and field survey techniques	12 th – 19 th May 2002	N/A	Silsoe, U.K.	Anthony Borg Shario Camilleri William Camilleri Sonya Vella	7214	08/05/02	1,039.00		
Training: Soil sampling and field survey techniques	12 th – 19 th May 2002	N/A	Silsoe, U.K.	Anthony Borg Shario Camilleri William Camilleri Sonya Vella	N/A (Subsistence allowance)		6,131.00		
Training: Soil Information Systems	7 th – 14 th July 2002	N/A	Silsoe, U.K.	Shario Camilleri Sonya Vella Randall Caruana Stefan Farrugia Michael Sciberras	N/A (Subsistence allowance)		7,854.00		

³⁰

It is advised to sort this table by date of payment.

³¹

To be completed only if the beneficiary/partners have provided proof that VAT is not recoverable and therefore should be regarded as an eligible cost.

Training: Laboratory analysis and quality control	28 th July – 3 rd August	NA	Silsoe, UK	Sharlo Camilleri Maira Bonello Sonya Vella William Camilleri Michael Sciberras	N/A (subsistence allowance)				7,773.00

TOTAL	22,797.00
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5. DISSEMINATION (only for LIFE-TCY)

SHORT NAME OF PARTICIPANT: MAF

PROJECT N°: LIFE 00 TCY/M/036

5.5 Other Costs³⁶

Invoice/receipt		Date of payment (dd/mm/yy)	Name / Company name ³⁷	Description of the expenditure	Total without VAT €	Total with non recoverable VAT ³⁸ €
N°	Date (dd/mm/yy)					
4502	26/06/02	03/07/02	Vogue Labels Ltd	Publications, brochures: LIFE print laminated poster	67.00	
4506	26/06/02	05/07/02	Vogue Labels Ltd	Publications, brochures: LIFE print laminated poster, board mounted	154.00	
88070	25/06/02	01/07/02	Saviour Magro Ltd	Information to the public: competition prize	227.00	
4062	02/04/02	09/05/02	Vogue Labels Ltd	Publications, brochures: LIFE print laminated poster, size A2	313.00	
14437	25/06/02	19/07/02	Amazon (reimbursement to Josephine Engelbert)	Information to the public: competition prize	169.00	

TOTAL	930.00
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³⁶ It is advised to sort this table by date of payment.

³⁷ This concerns the person or company to whom the payment is made.

³⁸ To be completed only if the beneficiary/partner has provided proof that VAT is not recoverable and therefore should be regarded as an eligible cost.

8. OVERHEADS⁴⁹ (part 1)

SHORT NAME OF PARTICIPANT: MAF

PROJECT N°: LIFE 00 TCY/M/036

Invoice/receipt Or Accounting reference ⁵⁰ N°	Date (dd/mm/yy)	Date(s) of payment dd/mm/yy	Reference period from (dd/mm/yy) to (dd/mm/yy)	Type of overhead ⁵¹	Total cost for the reference period without VAT €	Total cost for the reference period with non recoverable VAT ⁵² €	Total cost charged to this project ⁵³ €
0067	24/06/02	5/07/02		Office stationery		11.00	
2551	27/06/02	3/07/02		Field maps		30.00	
508	27/06/02	0/07/02		Office stationery		64.50	
60525711	24/05/02	9/07/02		Car hire for fieldwork in UK		115.00	

TOTAL	658.50
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⁴⁹

⁵⁰

⁵¹

⁵²

⁵³

It is advised to sort this table by date of payment. Please, refer to art. 21.12 of the Standard Administrative Provisions for more details.
You may list overheads in an analytical way (e.g. each telephone bill) or grouping them by type and period. If overheads are accounted for using an internal coding system, please insert here the appropriate accounting reference.

Give a short and clear description of the type of overhead (e.g. telephone, rental for office, etc).

To be completed only if the beneficiary/partner has provided proof that VAT is not recoverable and therefore should be regarded as an eligible cost.

In the following page you shall describe and justify the method used to allocate overheads for this project.

