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CSIRO National Soil Archive Manual

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Australian Collaborative Land Evaluatic

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CONTENTS

Acknowledgments **3**

Executive Summary **4**

Introduction **5**

1. Management **6**

2. Why archive soil samples? **7**

2.1 International soil archives 7

2.2 Australia's National Soil Archive 8

2.2.1 How archived soil samples have been used for further research 8

2.2.2 Projects that have contributed specimens to the Soil Archive 8

3. Inventory **13**

3.1. Archiving progress 13

3.2. Prioritisation of samples series for archiving 16

4. Submission of soil specimens **18**

4.1 Policy statement 18

4.2 Submission procedure 18

4.3 Data requirements 19

4.4 Costs of submitting soil specimens 20

5. Operation **21**

5.1 Managing submitted soil specimens and soil data 21

5.2 Data Entry and data collation 22

5.2.1 Standardisation of soil data in the central database 22

5.2.2 CSIRO National Soil Database NatSoil 23

5.3 Archiving stored specimens 27

5.3.1 Stock take, labelling and transfer 27

5.3.2 Subsampling and scanning 29

5.4 Managing requests for specimens and data 30

6. Use of soil specimens **31**

6.1 Policy statement 31

6.2 Loan Procedure 31

6.3 Costs of using soil specimens 32

6.4 Use of soil data only 32

7. Occupational health and safety management **33**

References **34**

Appendix A: Archiving procedure **38**

Appendix B: Hardware **42**

Appendix C: Forms **44**

Submission Request Form 44

User Request Form – Soil Specimens 45

User Request Form – Soil Data Only 46

LIST OF FIGURES

Figure 1 Sampling locations of soil specimens in the CSIRO National Soil Archive
Figure 2 Archived soil specimens on numbered shelves
Figure 3 Number of archivable soil specimens over time
Figure 4 The boxed-up ‘pink card’ collection of 16,200 specimens
Figure 5 A recent ‘stored’submission from a state agency
Figure 6 Original field and laboratory sheets to be entered into NatSoil - includes a 1934 ‘pink card’
Figure 7 Standard field datasheet (front and back)
Figure 8 Entity-Relationship diagram for NatSoil
Figure 9 Plain English Reports generated in NatForm
Figure 10 Each specimen has a unique barcode which is a concatenation of the six highlighted variables.
Figure 11 A ‘fine earth’ archived soil specimen
Figure 12 A ‘whole soil’ archived soil specimen

LIST OF TABLES

Table 1 Major Australian research projects and their contribution to the CSIRO National Soil Archive
Table 2 Examples of soil specimens derived from over 200 different Australian research projects.
Table 3 Progress in archiving over time
Table 4 Archived sites compared to archived soil specimens
Table 5 Inventory of the CSIRO National Soil Archive (August 2011)
Table 6 Data requirements and desired data

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EXECUTIVE SUMMARY

The mission of the CSIRO National Soil Archive is to provide facilities and protocols for conserving the long-term scientific value of soil specimens and associated soil data, and to make these specimens and their data available for public research, both now and into the future when new analytical techniques may be brought to bear on the specimens.

This Science Report outlines the management and operation of the research facility that is the CSIRO National Soil Archive and discusses the collection. It provides a technical background for archive users and submitting agencies and may help others wishing to setup their own archive of soil specimens. The report also provides an inventory of the collection and describes the day to day running of the facility in detail. Finally, this Science Report outlines the existing policies concerning the soil specimens contained within the CSIRO National Soil Archive, which is useful for agencies wanting to submit or use soil specimens.

INTRODUCTION

The CSIRO National Soil Archive holds tens of thousands of soil specimens that were collected for the purpose of soil research, from the 1920s to the present (Figure 1). Archived soil specimens like these are invaluable "time capsules" for assessing temporal changes in soil properties, particularly as new analytical tools become available (Boone et al., 1999). The collection of soil specimens is accompanied by a database holding soil data that was collected during field work and laboratory analysis. With increasing costs of developing new data sets, the ability to re-analyse existing soil samples and soil data has become increasingly valuable. The archived collection supports pedological studies with a national perspective as well as studies with a historical scope.

The mission of the National Soil Archive is to provide facilities and protocols for conserving the long-term scientific value of soil specimens and associated soil data, and to make these specimens and their data available for public research, both now and into the future when new analytical techniques may be brought to bear on the specimens. The National Soil Archive is supported in its mission by the Australian Collaborative Land Evaluation Program (ACLEP) and the National Committee on Soil and Terrain (NCST).

The archiving of stored specimens is ongoing. In recent years several state agencies have contributed their soil specimens to the National Soil Archive for long-term storage, and tens of thousands of soil specimens from state agencies and national monitoring and soil research programs are scheduled to be added to the archive collection in the future.

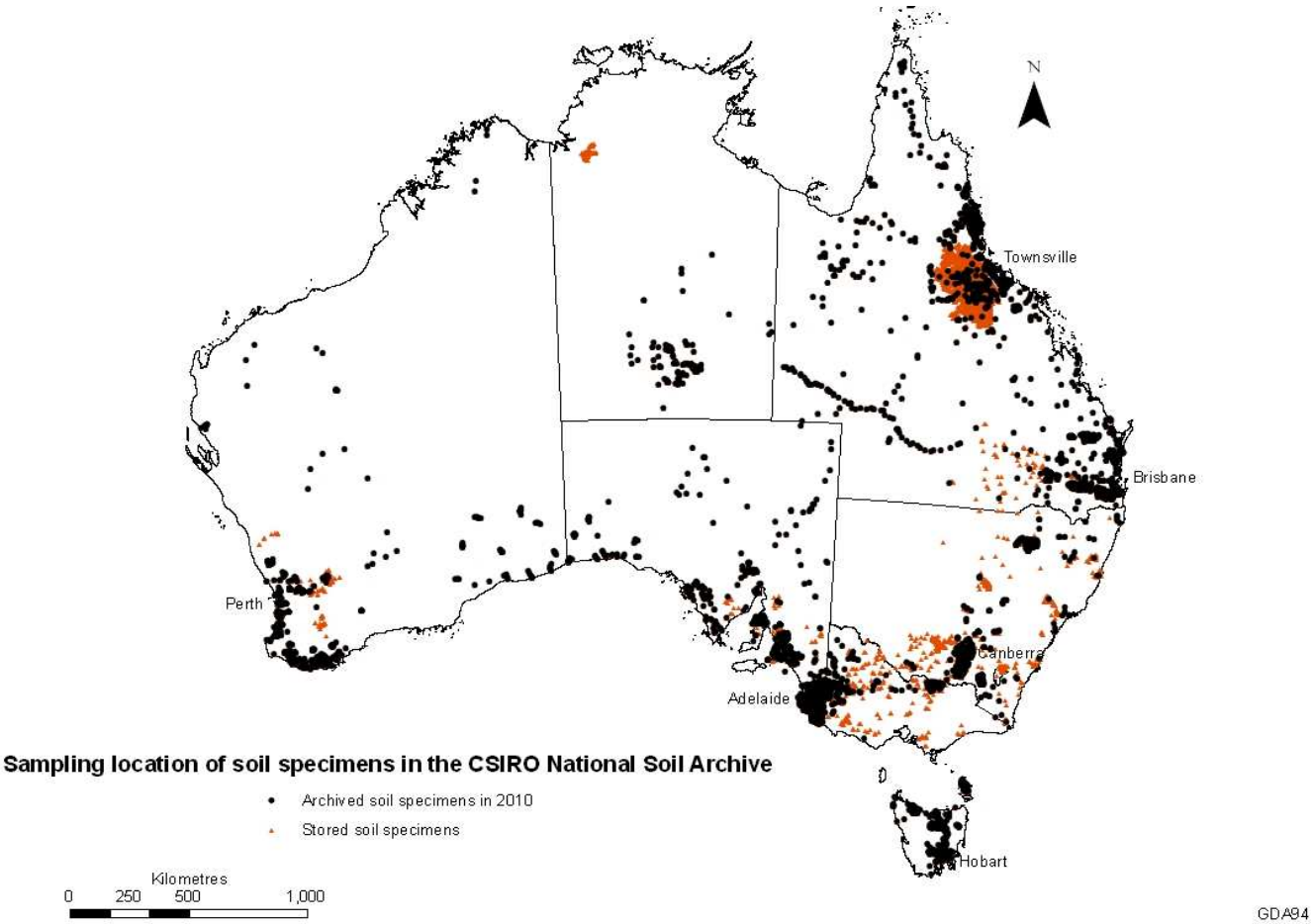

Figure 1 Sampling locations of soil specimens in the CSIRO National Soil Archive

1. MANAGEMENT

The CSIRO National Soil Archive is managed through an internal CSIRO steering committee. The committee comprises of the Research Group Leader of the Soil and Landscape Science group, the Research Team Leader of the National Soil Information Centre, the NatSoil database administrator and the CSIRO National Soil Archive Manager. The members of this committee were selected on the basis of their complimentary skills and knowledge of archival processes, the needs of the science community, database requirements and archiving logistics. The committee's role is to guide management of the Soil Archive. The committee sets out priorities and directions and decides on major submissions and loans. It also discusses ways of increasing the operational capacity of the National Soil Archive. Committee priorities are to ensure the fair and equitable access and use of soil specimens now and in the future, to oversee and regulate operational activities to ensure integrity of specimens and to facilitate support and promote the CSIRO National Soil Archive as an important national asset. Committee members meet on a regular basis, at least 3 times a year or as required when a significant submission or user request needs consideration.

The charter of the CSIRO National Soil Archive Committee is to:

- assist the development of policies
- oversee and provide guidance to the management of the CSIRO National Soil Archive
- review and assess requests for both the submission and the use of archive soil specimens
- ensure standards and quality control of processes to maintain archive soil specimen integrity
- review procedures

The management and care of soil specimens in the collection is through principles of respect for the scientific, physical, historical and aesthetic integrity of the specimens and their associated data, and the recognition that a specimen's condition generally cannot be improved if it receives improper handling. The archive manager is responsible for the care of archived collections. Frequent monitoring of specimens and storage facilities and using professionally accepted techniques for specimen treatment provide for this care.

As steward of historic soil specimens, the Committee's responsibilities are:

- to maintain the chemical and physical integrity of the specimens;
- to maintain documentary records of the specimens;
- to document the use of these specimens and any new research results (e.g. calibration method of new analytical methods, survey of previously measured soil properties, confirmation of previous measurements);
- to report any changes or factors that affect future use of the specimens (e.g. quantity available, storage conditions, accidents); and
- to ensure that users of the archive are keenly aware that the quantity of specimen is limited and great care is needed to ensure sufficient material is available for future users.

The guiding principle of the CSIRO National Soil Archive is to maximize the accessibility of soil specimens for research, while ensuring that sufficient soil material will be available for researchers in future decades and centuries.

2. WHY ARCHIVE SOIL SAMPLES?

Archived soil specimens can support problem-solving soil research by allowing calibration of new analytical methods, by enabling the development of baseline national soil property maps and by providing soil material for carbon cycle research. Care and commitment are needed to establish a world-quality soil archive and the long-term value ought never to be compromised by short-term gains: decisions of policy makers of the future must rest on the best possible data (Leigh et al. 1994). The maintenance of an archive for soil samples is not trivial and requires continued financial support and institutional commitment (Boone et al., 1999). To secure the future of soil archives it is essential that their importance is recognized by the whole scientific community and, importantly, by those who fund the work. This requires foresight, patience and an awareness of the great potential value of the information that can emerge from archived samples. It also involves collection owners taking responsibility for their collections and being held accountable for their long-term care. Besides being an unrivalled resource for addressing many established issues, soil archives have the potential to provide answers to agricultural and environmental problems not yet recognised.

2.1 International soil archives

Accessible historical soil samples combined with well-organised legacy soil data can open up a fertile field of study. The Rothamsted soil and crop archive for instance, has become as important as the renowned experiments from which it is derived (Leigh and Johnston, 1994). Outcomes of using the archived soil specimens from the Rothamsted collection include 1) models for the turnover of carbon and nitrogen in soil, 2) evidence of steady rates of increase in concentrations of dioxins during the last century, and 3) a model for losses of calcium and the need for lime (Rothamsted Research, 2006).

The biggest soil research organisation in Switzerland, the Swiss Federal Institute for Forest, Snow and Landscape Research, started a soil sample archive after 11,000 top soil samples were taken during a national forest inventory in 1985. The Swiss soil archive now consists of over 40,000 soil samples from around 1,500 soil profiles. The archived soil samples have been used to study changes in heavy metal content of soil over time and have enabled total elementary load studies of 1050 samples with respect to acid rain. Magnetic properties of soils and carbon stocks of mineral forest soils in Switzerland could be studied without a need for fieldwork. Archived Swiss soil samples have also been used to calibrate models (Lüscher and Blaser, 2000).

The National Uranium Resource Evaluation archive, based at the U.S. Geological Survey, houses hundreds of thousands of archived sediment and soil samples that were collected in collaboration with many other agencies, has re-analysed thousands of samples. These were previously analysed at different laboratories, each using its own set of methods, but have now been re-analysed at one laboratory using a standardized procedure to attain a consistent national data set of geochemical information (U.S. Geological Survey, 2007).

Also based in the US, is the Hubbard Brook Sample Archive, affiliated with the Hubbard Brook Experimental Forest. Besides soil samples, it stores vegetation samples (like Rothamsted) and water samples. The significant discovery of the link between the use of fossil fuels and increased acidification of rain and snow in North America was supported by the Hubbard Brook Sample Archive (Likens, 2004).

2.2 Australia's National Soil Archive

2.2.1 How archived soil samples have been used for further research

A number of archived soil samples in the collection of the Soil Archive have already proven to be of great value for a range of applications, even when the samples were stored at separate locations, before the CSIRO National Soil Archive was established. Some examples of this are the establishment of conversion factors to compare formerly disparate data on organic matter (Skjemstad et al. 2000), a national review of sodic soils (Naidu et al. 1993), rapid assessment of the distribution of soil with toxic levels of boron (Cartwright et al.1983) and the development of indices for characterising self-mulching soils using Vertosols from all over Australia (Grant and Blackmore, 1991).

Since the CSIRO National Soil Archive was set up, archived soil samples have enabled many further studies:

- A study of soil organic matter in rangeland soils in Queensland by Jan Skjemstad (pers. comm.) has allowed assessment of carbon sequestering potential as a result of rural land use and management.

- An early version of the Australian Soil Resource Information System (ASRIS) was based on the NatSoil database which holds the soil data of the Soil Archive's soil specimens (Johnston et al. 2003).

- A study on vegetation indicators of soil salinity in north Queensland used National Soil Archive samples (Bui and Henderson, 2003).

- One of many acid sulfate soils studies at Lake Albert re-analysed archived samples that had been collected in 1930 from the floor of Lake Albert. The considerable period of time (i.e. 78 years) that had elapsed since the original sampling provided an opportunity to observe the changes from exposure of the samples to oxygen while in an air-dry condition (Fitzpatrick et al., 2008).

- Archived soil samples and associated soil data have allowed calibration of several new instruments, for example those for measuring gamma radiometric and Electromagnetic Radiation and Near Infra Red (NIR) and new Mid Infra Red (MIR) Spectroscopy Scanners.

- Archived soil samples currently continue to enable the development of national soil diffuse reflectance libraries to characterise soil composition and diversity (Viscarra Rossel et al. 2006; 2008; 2010). The spectroscopy results of the research led by Raphael Viscarra Rossel of tens of thousands of soil samples from around Australia will facilitate the development of digital soil maps of mineral and organic components and are a major current impact of the Soil Archive.

2.2.2 Projects that have contributed specimens to the Soil Archive.

The oldest specimens kept in the CSIRO National Soil Archive were collected in 1927. In those early days soil surveys set out to determine the most appropriate land use for an area, and the best methods for their development and improved productivity.

Trace element research carried out in South Australia during the 1930's and 1940's led to substantial productivity improvements in pastures and cereals.

Land systems surveys such as the CSIRO Land Research Surveys (now available online at www.publish.csiro.au/nid/289.htm) in the 1940's and 1950's covered large tracts of Australia. Quite a few of the soil specimens from these soil surveys, now in the collection, were sampled before the start of nuclear testing in 1945. Many were collected prior to widespread application of pesticides and herbicides.

Since the middle of the last century soil research has also been targeted at contaminants, mineral deficiencies affecting crop yield, soil acidity and soil structure decline. Soil and land information was seen as essential to the valid extrapolation of field experiments and to provide context for laboratory research.

More recent surveys have focused more on land capability studies and the effect of forestry practices. The samples in the collection of the CSIRO National Soil Archive reflect these changes in research focus over time (Table 1).

Table 1 Major Australian research projects and their contribution to the CSIRO National Soil Archive

Project	Period	Study Area	Study Focus	Sites	Specimens
Ninth Congress of the ISSS (Northcote et al. 1960-1968)	1960's	Australia wide	Soil nomenclature	45	456
Handbook of Australian Soils (Stace et al., 1968)	1960's	Australia wide	Handbook of Australian Soils	120	1,800
National Soil Fertility Project (Colwell, 1979a,b)	1970's	Australia wide	Soil fertility mapping	335	2,800
Edgeroi, Lower Namoi Valley Project (McGarry et al., 1989)	1980's	North eastern NSW	Cracking clays, productivity	210	2,000
Cooloola (Thompson,1981; Thompson et al., 1984; Reeve et al., 1985; Tejan-Kella et al., 1991a)	1980's	Coastal south Queensland	Landscape dynamics, geomorphology	36	902
Soil Structure Management (Geeves et al., 1995)	1980's-1990's	Wheat growing lands Southern NSW northern Victoria	Soil degradation	101	300
Bago-Maragle Forest Soil Survey (Ryan et al, 1996; 2000)	1990's	South eastern NSW	Sustainable management of forests	165	1,054
Dalrymple Study (Williams et al., 1997)	1990's	Grazing lands Queensland	Tree clearing, salinity	2,525	3,760

In the last decades Australia's soil science scene has focused more on presenting existing knowledge to decision makers by use of modelling and Geographical Information Systems and less on fieldwork and laboratory research (McKenzie et al. 2005). Recent investigations by universities and research organisations include a series of projects on the prediction of the impact of global warming on agricultural production.

The National Soil Carbon Project, whose objectives include the provision of a nationally consistent assessment of soil carbon condition across the major land-use/soil type combinations used for agricultural production across Australia and the provision of data for further development of

Australia's national carbon accounting tool, has pledged these soil samples taken into the course of that study to the care of the CSIRO National Soil Archive.

The Terrestrial Ecosystem Research Network (TERN) is establishing a network of approximately 1,000 scientific reference sites to measure baseline ecosystem condition across the arid interior (known as the Australian Rangelands) covering large areas of South Australia, Western Australia, Northern Territory, Queensland, and New South Wales. These soil samples will also be housed in the CSIRO National Soil Archive.

Table 2 provides more background about 14 of the most important Australian research projects that have provided and will provide soil specimens to the CSIRO National Soil Archive. Where the opportunity exists to streamline some archiving tasks into the data collection and analysis stage such as with current national research programs, it is taken up in collaboration between the Archive and the submitting organisation.

Table 2: Examples of soil specimens derived from over 200 different Australian research projects

The development of the Factual Key (Northcote 1960; 1979) followed a study of about 500 soil profiles from widely distributed areas in Australia, with the greater number coming from the south eastern portion of the continent. The various properties used in describing the soil profiles were coded onto record sheets and the sorting and analysis of the record sheets resulted in a general framework for a key. The initial Key was gradually extended, and was completed after "The Atlas of Australian Soils" was finalised. The Atlas of Australian Soils is still the only consistent source of spatial information for the complete continent. The atlas was completed in 1968 (Northcote et al. 1960-1968) and was made available in digital form in 1990 (McKenzie and Hook, 1992).
A valuable collection of soil samples associated with "A Handbook of Australian Soils" was assembled by Stace and his colleagues (1968). The ninth International Congress of the International Soil Science Society was held in Adelaide in 1968, and there were various tours associated with it. Soil collected from profiles from these Congress tours contribute the majority of the samples used for the Handbook (the Stace collection). These well-sampled profiles (10 cm or smaller layers to a depth of 90 cm and often deeper) have been subject to detailed analysis and micro-morphological description.
In the 1970's, the CSIRO Division of Soils - in collaboration with State departments and the fertiliser industry - initiated the National Soil Fertility Project (NSFP) to study relationships between the fertility, composition and classification of soil in important agricultural regions of Australia. Approximately 3,000 samples were taken from around 300 sites in the ACT, NSW, Victoria, SA and WA that were selected to represent particular types of soil. Soils were described, sampled (predominantly the top 100 cm) and analysed. Nitrogen and phosphorus fertilizer experiments were carried out in conjunction to provide measures of fertility and fertilizer requirements. It was found that water-soluble nitrogen in the upper soil at the time of fertiliser application has a strong yield response for nitrogen fertiliser (Colwell, 1979a, b).
The Edgeroi dataset covers 210 sampling sites with 2674 samples taken on an equilateral grid covering some 1500 km^2 in the lower Namoi Valley in North Eastern NSW. It has supporting chemical data for 15 attributes measured at standard depths: pH and electrical conductivity, chloride and nitrate, bicarbonate, extractable phosphorus, exchangeable basic cat ions (Ca, Mg, Na, K), extractable aluminium, calcium carbonate, organic carbon, silt and clay. The cracking clay soils of this subhumid region near Narrabri are among Australia's most productive areas for cereal cropping, irrigated cotton and a large number of summer crops. The soil data provides information on the regional soil resources that enable these agricultural enterprises. This study investigated the relation of the cracking soils to the landscape and its geomorphic history (McGarry et al.1989).
The Cooloola samples are from a sand dune system 150 km north of Brisbane where a large and successful multi-disciplinary research project into landscape dynamics was undertaken. This work yielded tens of scientific papers including Thompson et al., (1996), Thompson and Moore (1984), Thompson (1981, 1999), Farmer et al. (1983), Reeve et al. (1985), Skjemstad et al. (1992) and Tejan-Kella et al. (1991a). Thirty-two deep profiles yielded 902 soil samples for the archive. Soil profiles were described following McDonald et al. (1984) and classified to both the Australian Great Soil Groups Classification (Stace et al. 1968) and Soil Taxonomy (Soil Survey Staff 1990).
A soil study of the lower Macquarie Valley in New South Wales involved detailed characterisation of 224 soil profiles along five transects. In this region the geomorphic history is the key to the present soil distribution. Complete soil morphological descriptions were recorded for the profiles exposed in backhoe pits to a depth of 1.50 m. Around 900 bulk samples were collected at four depth intervals. EC, pH and chloride concentrations as well as gravimetric water content were determined. Basic exchangeable cat ion determinations were restricted to two samples per profile. CEC was estimated by using the sum of four basic cat ions (Ca, Mg, Na and K). Water content, air-filled porosity and bulk density were also determined. Clay mineralogy was studied in 20 samples (McKenzie, 1992).
A large study of the physical, chemical and morphological properties of soils in the wheat belt of southern NSW and northern Victoria was undertaken by the CSIRO Division of Soils and the NSW Department of Conservation and Land Management. Seventy-eight sites were selected non-randomly to represent the full range of land management systems on the major soil types of the regions. Descriptions were made of each site, surface soil and vegetative features and profile morphology. In addition, information was collected on the history of the paddock. Just over 100 profiles yielded 624 samples. Measurements included soil hydraulic conductivity, soil moisture characteristics, bulk density, particle size distribution, soil strength, aggregate stability, total carbon content, soluble and exchangeable cat ions and soil pH (Geeves et al. 1995). The results for sites under crops and grazed pasture indicate that in the study area, soil based constraints to plant productivity exist in surface and subsurface horizons. This suggests that the severity of both induced soil degradation and inherent soil based constraints to plant growth, found at the sites, is representative of the wider south eastern wheat-belt.

For the heavily forested Bago-Maragle study area in south-eastern NSW, conventional survey methods were inappropriate (Ryan et al. 1996). Instead of conventional survey methods, geology, climate and landform were classified and then used to generate a digital stratification of the Bago-Maragle study area (each stratum representing a discrete environment). To do so technological developments like GIS, digital elevation modelling, remote sensing and terrain analysis were used. The field survey yielded 1054 samples from 165 selected sample sites. Detailed measurements were made of soils, vegetation and fauna. The survey data was used to generate digital maps of key land qualities such as erodibility, nutrient status and the soil water regime which allowed predictive modelling of key land qualities relevant to ecologically sustainable management of Australia's native forests.
In the 1980s the Western Australia Department of Agriculture commenced a 15 year program to map the soil-landscapes of the Agricultural Area in Western Australia. This mapping covers approximately 315,500 sq km (11.2 %) of the south-west of Western Australia, from Geraldton to Esperance. The regional mapping program continued through the 1990s and was completed, at least in a linked digital coverage, in 2003. The point data include site description, soil profile description, soil profile chemical properties and soil profile physical properties. Soil samples were held by the Natural Resource Management Group from the Western Australian Department of Agriculture and Food in Perth (Schoknecht et al., 2004).
The Dalrymple study was a collaborative project between the Queensland State Department and CSIRO. The Dalrymple shire covers an area of 60,000 km^2, with a main land use of extensive cattle grazing. Data was obtained from 2559 sites on 72 soil types. Additional analysis for basic cat ions and CEC was performed on 625 samples from the top 10 cm of their profile. Of these 625 samples, 399 also were analysed for acid extractable phosphorus, bicarbonate extractable phosphorus and extractable sulphur (Rogers et al., 1999; Bui, 1997). 187 reference sites with detailed profile descriptions, chemical and physical analyses were sampled. These extra soil samples were also used in a wider phosphorus study by the Queensland Department of Primary Industries.
The Desert Uplands Strategic Land Resource Assessment project (DUSLARA) followed in the footsteps of the Dalrymple study. Sampling took place from 1999 to 2003 in north-central Queensland between Chartres Towers and Hughenden in the north and Alpha, Blackall and Barcaldine in the south, a study area of approximately 850,000 sq km. Three years of intensive fieldwork involved collecting site soil and vegetation information from six of the seven shires involved in the area. The data was analysed, maps were produced, reports were written and a user-friendly digital database was created. The Dalrymple shire data was collated (35 % of the study area) and the project was finalised in 2005. A total of 381 primary sites were described, yielding a total of 1,176 soil samples of 1 kg, which were all analysed (20 soil chemistry measurements per sample) at the same laboratory. Slaking and dispersion were also measured (Lorimer, 2005).
The Soil Condition Evaluation and Monitoring (SCEAM) Project commenced in 2004 and monitors soil condition across Tasmania to determine the long-term effects of different land uses and management practices on soil health. Tasmania was one of the first Australian states to implement a scientifically sound monitoring system, which has established 100 long term reference sites in each NRM Region (300 in total) and a database of Tasmanian, state-wide base-line soil condition data. The sites are revisited every 5 years. The project, which is largely based on the "500 Soils" monitoring program in New Zealand, is funded by the National Heritage Trust and is a joint initiative between The Department of Primary Industries, Parks, Water and Environment, The Tasmanian Institute of Agricultural Research and the Cradle Coast, Northern and Southern Natural Resource Management (NRM) Regions (Grose et al., 2005).
The Agricultural Production Systems Research Unit (APSRU), the joint research team from the Queensland State Government and CSIRO, based in Toowoomba submitted 500 soil samples that were collected in NSW and SA in the course of research into soil water holding capacity on farms. The extra value of this series lies in the fact that soil moisture retention properties were measured (rained upper limit DUL, crop lower limit CLL, bulk density, plant available water capacity (PAWC)). Up to 4,000 samples from the FARMSCAPE project were submitted in 2011. For these 80 gram samples data is limited to basic soil chemistry (especially nitrate nitrogen) (Dalgliesh et al., 2009).
The National Soil Carbon Research Program is carried out by state government agencies, universities and CSIRO and is coordinated by CSIRO. It has established a nationally standardised method for collection and analysis of soil carbon samples and is applying consistent and cost-effective methods of analysis (mid infrared spectroscopy) and statistical analysis. The data will show the impact of agricultural management on storage of soil carbon over a wide range of geographical regions, soil types and climates. More than 2000 sites representing the dominant soil types within the major agricultural production systems in Australia will be sampled by the program. The program will also establish a baseline for soil carbon levels against which future changes can be compared and tracked. The National Soil Carbon Research Program will submit an estimated 16,000 soil specimens from agricultural lands around Australia with associated carbon data. The soil data will remain confidential until published by the various State collaborators. For this project of national importance the NatSoil database was adjusted slightly to accommodate data storage. In addition, archive labels are produced in Adelaide, where soil analysis takes place, at the time the samples are assigned their first laboratory ID, to increase efficiency of archiving and processing (pers. comm. Jeff Baldock, CSIRO Land and Water, Adelaide).

3. INVENTORY

The CSIRO National Soil Archive can be found on the CSIRO Black Mountain site in Canberra, and is currently housed in the eastern part of building 210. The available space consists of a main room of 15 by 16 m and two internally accessible small offices. Temperature inside the archive building ranges between 10 and 32 degrees Celsius. Relative humidity inside the archive building varies between 18 and 62%. The site has a low risk of flooding as it is located high on a hill slope. An archive style sprinkler system is installed and while the site is adjacent to bushland, the risk of bush fire is limited because a power substation is located between the surrounding bush land and the archive building, providing immediate attention of the fire brigade in case of bush fires. There are 32 racks with a storage capacity holding of 2,400 jars each. These are organised in 18 bays. The total storage capacity is around 65,000 jars, which equals 55,000 samples (15% of samples have required two jars). The jars are stacked 4 deep and 3 high on a numbered shelf (Figure 2). The shelf address of any archived sample can be accessed in the database.

Figure 2 Archived soil specimens on numbered shelves

3.1. Archiving progress

The speed with which archiving progresses depends largely on the quality and format of the submitted soil data and on the way the soil samples have been labelled and packaged in the past. A submitted series, consisting for instance of 3,000 soil specimens stored in 500 ml paper cups (with clear labelling), containing material smaller than 2 mm, with the attached soil data already archived in the database, will permit faster processing than a submitted series of 1,000 clayey soil specimens soils, presented in huge aggregates kept in plastic bags that have been tied close, with data in spreadsheets organised by field experiment. Similarly, the way in which boxes containing the samples have been organised and labelled affects the ease and speed of processing. In cases where more than 1 litre of soil material is submitted per sample - the Townsville Division of Soils commonly used 2 litre glass jars - two or more archive jars will need to be prepared and weighed to fit the larger than average amount of soil material. These differences add up incrementally over thousands of samples. Table 3 below gives an overview of archiving progress at 0.4 FTE from 2003 to 2010.

Table 3 Progress in archiving over time

Year	2003	2004	2005	2006	2007	2008	2009	2010
Archived soil specimens	0	4,000	5,000	5,200	7,000	3,400	3,000	5,900
Unarchived soil specimens (original collection)	41,300	37,300	32,300	27,100	20,100	16,700	13,700	11,800
Submitted soil specimens	0	0	0	500	1,200	300	3,600	4,500
Total archivable specimens	41,300	41,300	41,300	41,800	43,000	43,300	46,900	51,400
Unarchivable specimens 'pink card collection'	16,200	16,200	16,200	16,200	16,200	16,200	16,200	16,200
Total of all specimens in the collection	57,500	57,500	57,500	58,000	59,200	59,500	63,100	67,600

The CSIRO National Soil Archive was established in 2003 and incorporated the collections of the previous CSIRO Divisions of Soils of Brisbane, Townsville, Adelaide, Canberra, Perth and Hobart. A total of around 41,000 unarchived soil samples were delivered, boxed up, to the newly established Soil Archive which have been been progressively archived since then (Figure 3).

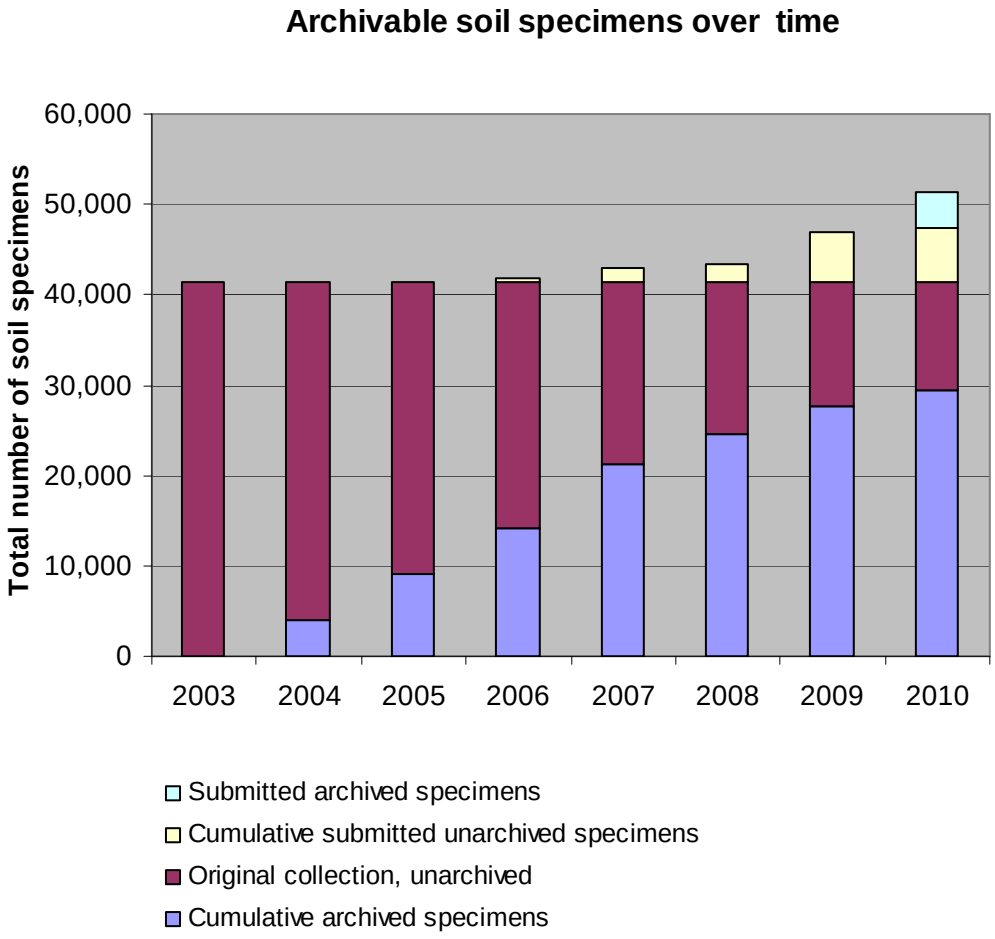

Figure 3 Number of archivable soil specimens over time
(Note: the 'pink card' series is not shown)

On top of these circa 41,000 soil samples, some 16,000 samples from the 'pink card' series, stemming from before the time of good geo-location, were relocated from Adelaide to Canberra. Retrospectively

establishing geographical references for samples from the ‘pink card’ series is most challenging but not impossible, and may occur in the future. The ‘pink card’ series represents some of the earliest soil specimens in the archive collection, with some having been sampled as far back as 1924, and has always been well-managed (Merry, 1985). Samples from the ‘pink card’ series have therefore been accessible even while unarchived in the new system. They have been used for soil research on several occasions in the last 5 years and record management has required the archiving of the original field books. Ultimately this will allow the pinpointing of the sampling locations of these very old specimens retrospectively. For now, the ‘pink card’ series is referred to as ‘unarchivable’ (Figure 4).

During the 1990’s and 2000’s, data entry into the SITES-conforming Microsoft Access database that was later became NatSoil had started. There are four categories of soil specimens in the archive: archived soil specimens (48%), stored specimens with data in database (12%), stored specimens without data in database (16%) and the pink card collection (24%). ‘Archived’ samples have had both soil data archived in NatSoil, and the soil material archived on the shelves of the soil archive (Figure 2). The category ‘stored specimens data in database’ refers to those samples for which the soil data has been entered into NatSoil, but that are not as yet archived (Figure 5). To archive soil samples belonging to the category ‘stored specimens data not in database’, two labour-intensive tasks are still required: firstly data entry to populate NatSoil (data archiving), and secondly the archiving of the soil material.

Figure 4
The boxed-up ‘pink card’ collection of 16,200 specimens

Figure 5
A recent submission from a state agency

Since 2007 new submissions have contributed over 10,000 more soil specimens. In most cases the data-entry for these more recent samples is not quite as labour intensive as the earlier samples, because the soil data is submitted in digital format e.g. Microsoft Excel spreadsheets or Microsoft Access databases.

Leaving the pink card series out of consideration for a moment, the 2011 figures for the holdings of the archive were as follows: 64% of all soil samples held in the collection were fully archived, 16 % of the soil samples in the collection had data in the database but are not yet archived and a further 20% required both data archiving and soil material archiving.

Finally, it is worth making a note on the relationship between sites and samples. Some submitting agencies think in terms of number of sampling *sites*, while archive users are frequently interested in the amount of available *specimens* to suit their purpose. Depending on the purpose of the soil survey or study, few or many samples are taken per site. In a study of Podzol chronosequences on coastal dunes in Cooloola for instance, an average of 25 samples were taken per site, with some sites having 43 samples (Thompson, 1981). When the research interest is predominantly in the properties of top soil, as is the case in many agriculturally related studies, only the top 90 cm may be sampled. This is how in 2009, 2,845 samples from 455 sites were archived, an average of 6.3 samples per site, while in 2006 4,191 samples from 397 sites were archived, an average of 10.6 samples per site (Table 4).

Table 4 Archived sites compared to archived soil specimens

Year	Archived sites	Archived specimens	Average specimens per site
2004	492	2,969	6.0
2005	530	4,630	8.7
2006	397	4,191	10.6
2007	973	6,336	6.5
2008	555	2,671	4.8
2009	455	2,845	6.3
2010	456	5,900	12.9

3.2. Prioritisation of samples series for archiving

The mission of the CSIRO National Soil Archive is to make as many soil specimens and associated soil data available for public research as possible. This is done using limited resources, and prioritisation of which 'stored' and newly submitted soil specimens are to be archived first, is necessary. For a large proportion of the stored specimens data archiving has taken place in the 2000's at CSIRO Land and Water in Canberra. To make as many soil specimens available for further research as soon as possible, those stored specimens of which the soil data has been archived (i.e. entered into NatSoil) have been archived preferentially, to fill the shelves with accessible archived soil specimens at the fastest possible rate.

The criteria by which both the priority for submission and the order in which sample series are archived are determined are as follows:

1. Primary data from core research activities (significant studies, large surveys, experiments, significant sites) from CSIRO Divisions receive the highest priority, especially if there is a large series of specimens with standardised sampling and laboratory procedures. For most specimens in the Archive an estimated A$ 600 (at 2011 prices) has been invested per specimen, incurred by labour costs during fieldwork and laboratory preparation and analyses, and by the actual costs of chemical and possibly physical analyses.

2. Data collected by other sources to which CSIRO supported research has added value is also a high priority.

3. Other types of data including non-CSIRO specimens that were acquired for CSIRO research, student thesis data or legacy specimens and data that already suffer from inadequate documentation or format obsolescence, may be ranked a lower priority, with justifications provided in the data management policy.

4. Finally, some specimens may be determined to be of lowest priority for archiving on the grounds that it is not worth the effort involved in translating the data format for a small number of specimens. If too much information is missing, the chances that these specimens will be accessed is small, while the workload involved in tracing laboratory methods, translating units, interpreting observations and tracing original researchers before archiving is considerable.

The 2011 inventory gives a snapshot of the CSIRO Soil Archive's holdings (Table 5). As new submissions are negotiated and archiving of stored soil samples progresses the figures change. Please contact the CSIRO National Soil Archive for the most up to date information (www.clw.csiro.au/aclep/archive.htm).

Table 5 Inventory of CSIRO National Soil Archive (August 2011)

Origin	**Series name**	**Soil Specimens**	**Jars**
Archived specimens data in database			
Brisbane	B	**7,350**	7,350
Townsville	T	**5,700**	9,100
Adelaide	A	**6,150**	6,150
Northern Territory	NT	**750**	750
Perth	P	**550**	550
Acid Soils project	H	**800**	800
Hobart	AN, AV	**1,000**	1,000
Bago-Maragle project	BGM_FSS	**1,050**	2,100
Morphology project	Morphology	**450**	900
Soil Structure project	SSM	**300**	300
APSRU	APSRU	**4,600**	4,600
Edgeroi	Edgeroi	**2,000**	2,000
WA Dep. of Agriculture	ADA, GTN, JSI, KLC, MRA, NYA, TBO, WBW	**2,300**	2,300
	Total	**32,500**	37,400
Unarchived specimens data in database			
Perth	P	140	
Hobart	H	340	
National Soil Fertility project	NSF	2,800	
CSIRO Rhynie		120	
Canberra	C,CP	2,900	
WA Dep. of Agriculture	CHT, CLS, COR, CRA, DAN, FRA, KNX, MDN, NCP, RAV, SC2, SCS, SGS, SYP, TON, TSL, WCC	1,300	
Tasmania DPI	SCEAM	800	
	Total	**8,400**	
Unarchived specimens data not in database			
Desert Upland Project	DUSLARA	1,200	
Canberra	C, CP	1,450	
Boron (Cartwright)		2,700	
Torrens Valley (Tiller)		3,600	
Moomba Pipeline	M	1,150	
Adelaide and NT	A, NT	400	
	Total	**10,500**	
Unarchivable specimens			
Pink Card collection		16,200	
	Total	**16,200**	
	Grand Total	***67,600***	

4. SUBMISSION OF SOIL SPECIMENS

The CSIRO National Soil Archive stores tens of thousands of soil specimens. Archiving of stored soil specimens involves stock taking of stored samples, labelling, transfer of soil material and storage. For each archived specimen archive information is available in the database: how much material is present, whether as whole soil or fine earth, and on which shelf the specimen can be found. The label on every archived specimen indicates the agency, project, observation ID, site ID, horizon (name), depth, sample (where there are more specimens per horizon) and layer. Together these variables provide a unique ID for every specimen, which is expressed in the barcode on the label. Archiving of stored soil specimens is on-going.

4.1 Policy statement

To maintain important historic and contemporary soil specimens from around Australia for future analysis, the CSIRO National Archive supports continuing submission of additional collections of soil specimens to expand the Archive collection where possible.

4.2 Submission procedure

Specimens submitted to the CSIRO National Soil Archive are required to meet a number of criteria to become part of the collection. Organisations wanting to submit soil specimens need to describe the type and number of specimens, the amount of material per specimen, the amount of data, the data format, the research to which these specimens have contributed and justification for archiving using the Submission Form (Appendix C). Upon receiving this request, the CSIRO National Soil Archive Committee will review and assess the submission.
Priority will be given to specimens:

- supporting priority initiatives (e.g. Soil Organic Carbon Monitoring)
- representing important landscapes
- addressing knowledge gaps, either temporally or spatially
- used for widely publicised research
- with data available in NatSoil (Microsoft Access)

Specimens submitted to the CSIRO National Soil Archive may be accepted if they are within the scope of CSIRO's scientific interests and in good condition, have adequate documentation and if the CSIRO National Soil Archive can provide for their care. To assist with the capture and storage of soil information in the appropriate format, the archive provides data entry (NatForm) and storage (NatSoil) databases (Microsoft Access) upon request. **Documentation must be submitted to the database manager at the time the specimens are submitted or before samples submission.**

Physical requirements for acceptance into the Archive
Soil specimens need to be:

- non-toxic
- air-dried or oven-dried at 40 degrees Celsius
- stored in air-tight containers

Specimens that do not meet these requirements will not be accepted.

4.3 Data requirements

Supporting documentation is of primary importance to the scientific value of specimens. Pertinent data must be documented and **clearly linked to each specimen**. Detailed documentation ensures that a specimen's field data, history of use, physical condition and identification are known. These records may actually have to substitute for a specimen should it run out. Table 6 clearly outlines the data submission criteria.

Table 6 Data requirements and desired data

REQUIRED DATA

LOCATION

- Coordinates of the site location where the specimens were obtained.
- The datum of the coordinates. In the GDA 94 datum, latitudes and longitudes, with latitudes as negative in the Southern Hemisphere. In the Universal Transverse Mercator (UTM) coordinate system, the grid zone, northing, easting and datum are required.
- The method used to acquire the coordinates needs to be recorded as one of the following: map reference, GPS or Survey.

TYPE OF SOIL OBSERVATION
The type of soil observation from which the specimens are extracted needs to be recorded as one of the following: soil pit, existing vertical exposure, relatively undisturbed soil core or auger boring (NCST, 2009 p. 147).

DEPTH INTERVAL
Upper and lower depth of the soil specimens (m)

COLLECTOR
Name and contact details of person responsible for specimens

DATE COLLECTED
Date soil specimen was collected in the field

DESIRED DATA

MEASURED SOIL CHEMISTRY PROPERTIES, where known.

MEASURED SOIL PHYSICAL PROPERTIES, where known.

METHOD OF ANALYSES, must be specified for each measurement result or field value
The method of analysis must be recorded and this must reference a published source (e.g. Rayment and Lyons, 2010; McKenzie et al., 2002). If a published source is unavailable, complete documentation is required.

DATA FORMAT: Microsoft Access, Microsoft Excel or ASCII.

REFERENCES TO RELEVANT REPORTS AND JOURNAL PAPERS

When the Submission Request Form has been received, the Steering Committee of the CSIRO National Soil Archive convenes to evaluate the submission. After the submitting organisation has been advised of a positive assessment, details of data and specimen transfer are arranged with the archivist. The contributing organisation is responsible for documentation and must provide the CSIRO National Soil Archive with all available data and publications, while realising that the data will eventually be freely accessible to future archive users. Specimen transport to the CSIRO National Soil Archive will be at the submitting agency's cost unless otherwise negotiated.

Once the transfer is completed, the specimens will become and remain property of the CSIRO National Soil Archive. Specimens cannot be given out as 'permanent loans' as such arrangements are ambiguous with respect to control and financial responsibility. Submitting organisations will be able to access specimens that were previously their property according to the Policy on Specimen Use.

4.4 Costs of submitting soil specimens

Organisations may, where deemed appropriate, be charged archive submission costs of $20 per submitted specimen (at 2011 prices), particularly for large submissions. This is to partially cover the costs of stocktaking, labelling, transfer and storage. The CSIRO National Soil Archive is a small organisation that holds many tens of thousands of specimens. In many circumstances, the Soil Archive could not provide value-added services free of charge to researchers without reducing the amount of effort going into making soils specimens available for further research. It is recommended to budget for Archive Submission Costs when planning research projects.

5. OPERATION

Operating guidelines of the CSIRO National Soil Archive are based on maximizing the availability of the soil specimens while ensuring that sufficient soil material is available for users in future decades and centuries. As stewards of historic soil specimens, our priorities are to maintain the chemical and physical integrity of the specimens; to maintain documentary records of these specimens; to document the use of these specimens and any resulting changes and new research results; to report any changes or factors that affect future use of the specimens; and to ensure that users of the archive are keenly aware that the quantity of specimen is limited and great care is needed to ensure sufficient material is available for users in future decades and centuries.

The main operational activities in the National Soil Archive are 1) the management of incoming submissions of soil specimens and soil data, 2) the archiving of the soil data (data entry and data collation), 3) the archiving of the soil material, necessarily in that order, and finally 4) the management of user requests of soil specimens and soil data.

5.1 Managing submitted soil specimens and soil data

To maintain important historic and contemporary soil specimens from around Australia for future analysis, the CSIRO National Soil Archive supports continuing submissions of additional collections of soil samples and expansion of the archive collection where possible. For organisations interested in having their soil specimens contribute to the National Soil Archive, the archive website at http://www.clw.csiro.au/aclep/archive/index.htm provides a useful point of entry (Karssies, 2009). It explains the archiving procedure and, most importantly, provides potential users with practical information which will help them decide whether their specimens are eligible for archiving.

Soil samples that are submitted to the CSIRO National Soil Archive are required to meet a number of criteria to become part of the collection. Organisations wanting to submit soil specimens need to describe the type and number of specimens, the amount of material per specimen, the amount of data, the data format, and the research to which these specimens contributed and justifications for archiving, using the Submission Form. The form can be found on our website.

Upon receiving this submission request, the CSIRO National Soil Archive Committee will review and assess the soil sample and/or soil data request. Priority will be given to accept specimens:

- supporting priority initiatives (e.g. National Soil Carbon Research Program)
- representing important landscapes
- addressing knowledge gaps, either temporally or spatially
- used for widely publicised research
- with data available in NatSoil (Microsoft Access)

A meeting of the Soil Archive Committee is called to decide whether or not the proposed new series of soil specimens can be accepted, and if they are accepted, how the archiving activities will be allocated between submitting agency staff and soil archive staff.

No soil specimens may be sent to the soil archive without data and where possible, soil data will be passed to the archive before the specimens to allocate sufficient time for data archiving (data entry or data collation). Data archiving for a submission can take days or weeks of database work, depending on the circumstances and will vary from case to case. The submitting agency is invited to collaborate on the data archiving as they are best acquainted with the data. Where no in-kind contribution can be made, the submitting agency may be charged $20 per soil specimen (at 2011 prices).

5.2 Data Entry and data collation

5.2.1 Standardisation of soil data in the central database

The main value of the archived soil specimens lies in the associated soil data (location, morphology and chemistry data). All available information on the soil specimens is entered and held in a series of tables of a relational database. The CSIRO National Soil Database called NatSoil was designed for the purpose; it can store, archive and retrieve soil information for research and extension purposes (Peluso et al., 1995). A relational database was chosen because this type of database offers constraints and enforces relationships, ensures data integrity and allows for incomplete data. Databases also have the capacity to hold much greater numbers of records (into the billions) than spreadsheets. Even very large relational databases are quick to query, because all data is stored in tables, between which relationships are defined. These properties make relational databases the superior way to manage archive data.

Disparate data sets need to be entered into NatSoil before archiving can take place. Soil data, painstakingly obtained during field work and laboratory measurements, may be contributed in various forms; as paper copies of internal reports, or various digital formats such as ASCII text, VAX data, spreadsheets and different database systems. Because specimens cannot be archived when insufficient data is available, data retrieval can resemble a rescue operation. The biggest challenge is the diversity of record keeping and data management systems that were used. **Where soil data can successfully be recovered, this results in improved access, increased consistency and increased usability of legacy soil data.**

Substantial effort has been spent and will still need to be spent on transcription of the submitted data into the standard format (Figure 6). Because classifications have changed over time, a sound pedological knowledge and understanding of the changing nomenclatures over the last 50-year period is required when transcribing legacy data to the archive database. Subjective descriptions on original field cards, old categories, coding and units for various soil attributes often require reinterpretation and recoding to allow standardising. Inappropriate or insufficient checks on the effects of changes in methodology can limit the usefulness of a database to future generations. Because different laboratory methods often return different results for many soil attributes great care is taken to reflect this information in the database (Leigh et al., 1994; Ryan and Wilson, 2009). Once achieved, the standard data format allows easy, computerised manipulation of data.

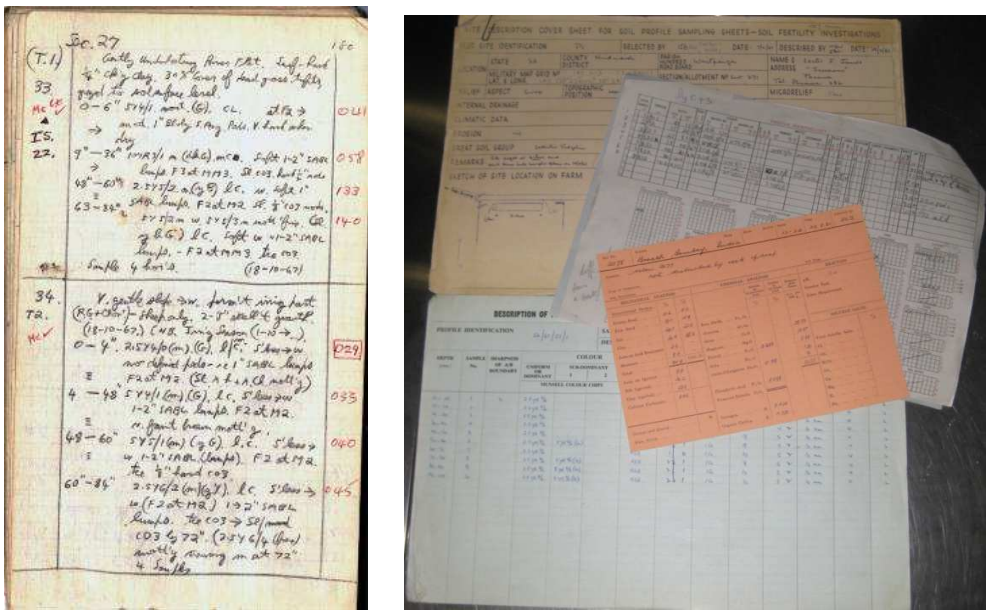

Figure 6 Original field and laboratory sheets to be entered into NatSoil - includes a 1934 ‘pink card’

5.2.2 CSIRO National Soil Database NatSoil

The CSIRO National Soil Database (NatSoil) was developed at CSIRO to store, archive and retrieve soil information which is used for research and extension purposes (Peluso et al., 1995). The design is flexible enough to accommodate future additions, modifications or deletions from the survey standards.The database has been designed to store morphological attributes as described in the *Australian Soil and Land Survey* series of handbooks (McDonald et al., 1990; National Committee on Soil and Terrain, 2009). The Field Handbook sets down standards of terminology and methodology for the survey of land resources and description and its use over the last 25 years and has achieved increased uniformity in the description of soil.

Soil information is entered into NatSoil (the data storage database) using NatForm (the data entry and decoding database). NatForm contains a series of easy to use Microsoft Access data entry forms, based on the Australian Soil and Land Survey Field Handbook field data sheet (Figure 7), to assist efficient data entry from this field sheet.

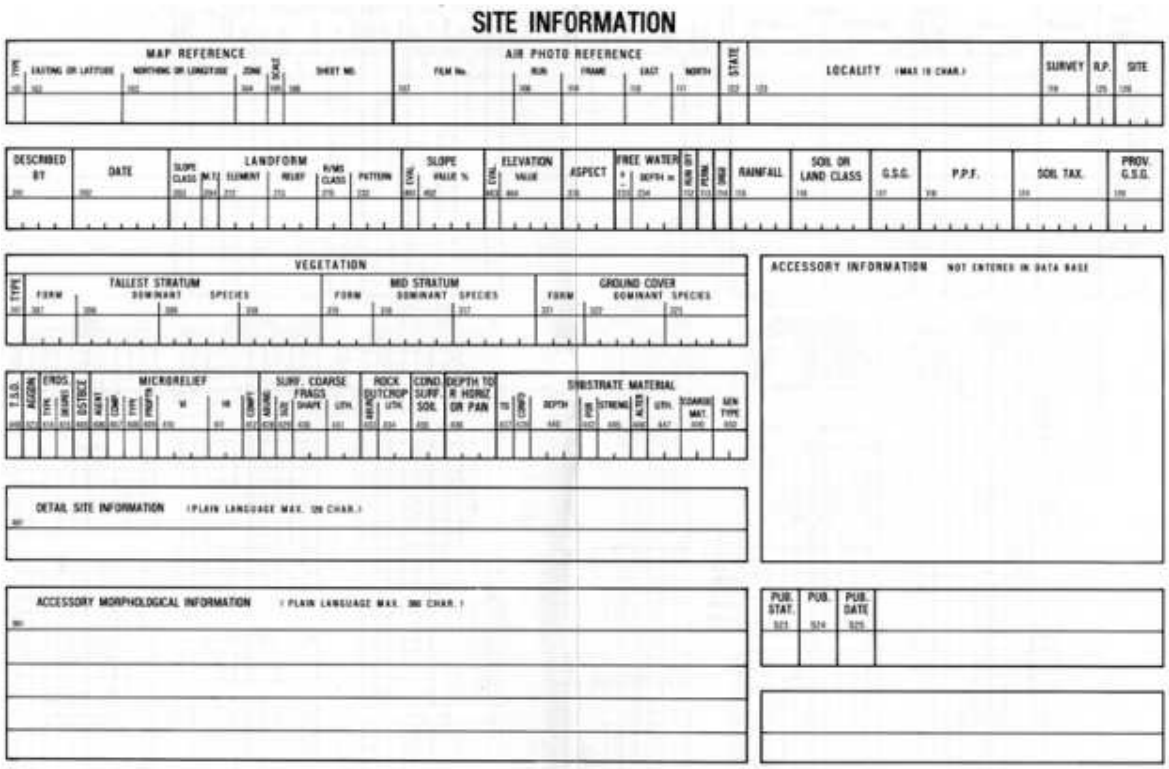

Figure 21 Example of field sheet (front)

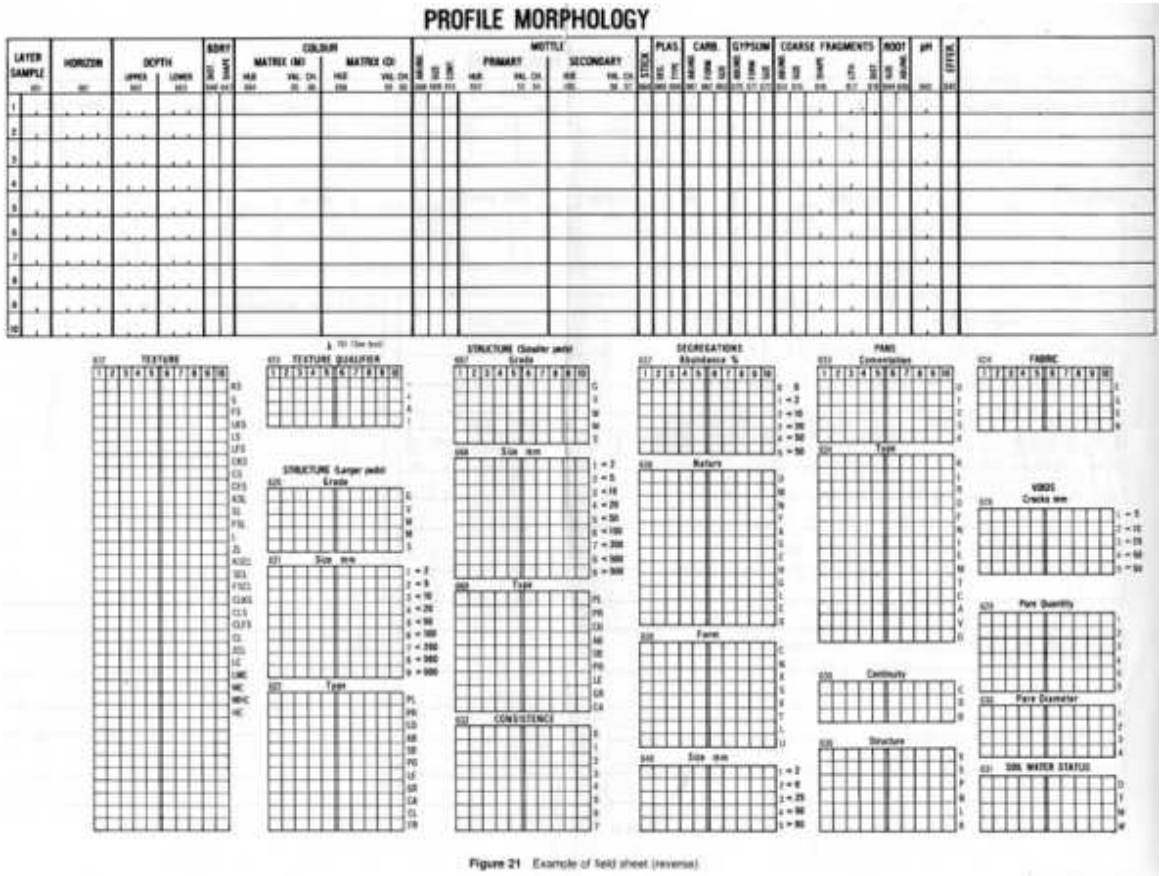

Figure 7 Standard field data sheet (front and back)

The specific soil information in NatSoil is stored into designated tables with unique combined keys. For example, all the information relevant to coarse fragments is stored in the Coarse_frag table together with unique combined keys like agency code, project code, site identification number and observation identification number. Similarly, all the information relevant to cutan information is kept in the Cutan table together with unique combined keys. The user can retrieve both coarse fragment and cutan information for the same site and project by matching site and project values from these two tables.

The database design also includes chemistry, physical, mineralogical and soil biota attributes which have historically been collected by CSIRO. These parts of the database are based on *Soil chemical methods - Australasia* (Rayment and Lyons, 2010) and *Soil physical measurement and interpretation for land evaluation* (McKenzie et al. 2002). An entity-relationship model is defined and SQL scripts have been produced to create tables and indexes (Figure 8). A codes table has been populated for validation and decoding, based on the above handbooks. Primary key fields are based on the natural key fields such as the Site ID and Observation ID, rather than artificial key fields. A number of Microsoft Access modules have been developed to simplify data entry and reporting; a data entry function and report generating function. Query and retrieval functions already exist in Microsoft Access.

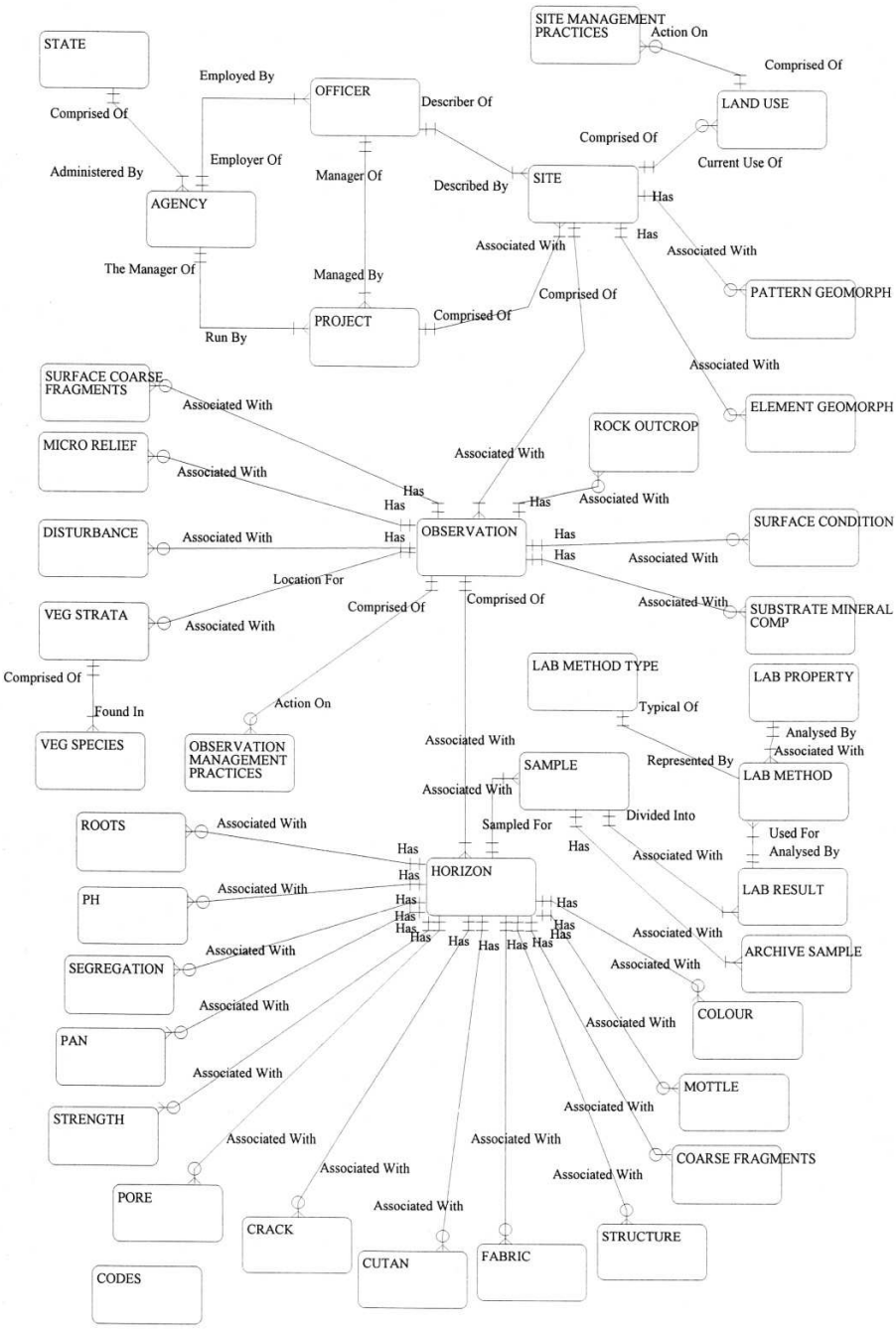

Figure 8 Entity-Relationship diagram for NatSoil

Soil profile reports can be generated using the NatRep Module (within NatForm), which is a ‘Plain English Report’ generating tool operating in Microsoft Access (Figure 9). The Text File module is designed to transfer the soil information into an ASCII format for data exchange purposes. The NatRep module performs the task of generating ‘Plain English Reports’ for individual soil profile records. The user can choose between morphology and chemistry reports, which can be printed, previewed or saved to file. Batching facilities are available to both print and save to file options (Peluso et al., 1995).

Project Name: CAN
Project Code: CAN
Agency Name: CSIRO Division of Soils (NSW)
Site ID: CP159
Observation ID: 1

Site Information

Desc. By:	P.H. Walker	Locality:	Flood behind levee CP 158
Date Desc.:	01/01/79	Elevation:	12 metres
Map Ref.:	Sheet No. : 9030	Rainfall:	800
Northing/Long.:	150.7225	Runoff:	Slow
Easting/Lat.:	-33.396666666667	Drainage:	Well drained

Geology

ExposureType:	Soil pit	Conf. Sub. Is Parent. Mat.:	No Data
Geol. Ref.:	No Data	Substrate Material:	Soil pit, Porous, Unconsolidated material (unidentified)

Land Form

Rel/Slope Class:	Gently undulating plains <9m 1-3%	Pattern Type:	Flood plain
Morph. Type:	Flat	Relief:	No Data
Elem. Type:	Valley flat	Slope Category:	Very gently sloped
Slope:	0 %	Aspect:	45 degrees

Surface Soil Condition (dry):

Erosion:

Soil Classification

Australian Soil Classification:		Mapping Unit:	N/A
Melanic Eutrophic Red Kandosol		Principal Profile Form:	Gn2.11
ASC Confidence:		Great Soil Group:	No suitable group

All necessary analytical data are available.

Site Disturbance: Cultivation. Rainfed

Vegetation:

Tall Strata - Tree, 3.01-6m, Mid-dense. *Species includes - None Recorded

Surface Coarse Fragments:

Profile Morphology

A1	0 - 0.15 m	Dark brown (7.5YR3/2-Moist); ; Loamy sand; Massive grade of structure; Weak consistence; Clear change to -
11A	0.15 - 0.3 m	Dark reddish brown (5YR3/2-Moist); ; Sandy loam (Light); Massive grade of structure; Weak consistence; Field pH 6.2 (pH meter);
A	0.3 - 0.45 m	Dark reddish brown (5YR3/2-Moist); ; Sandy loam; Massive grade of structure; Weak consistence; Gradual change to -
B1	0.45 - 0.67 m	Dark reddish brown (5YR3/3-Moist); ; Sandy loam (Heavy); Massive grade of structure; Very strong consistence; Field pH 6.2 (pH meter); Gradual change to -
B21	0.67 - 0.88 m	Reddish brown (5YR4/4-Moist); ; Clay loam; Massive grade of structure; Very strong consistence; Field pH 6.2 (pH meter); Gradual change to -
B22	0.88 - 1.1 m	Yellowish red (5YR4/6-Moist); ; Clay loam; Massive grade of structure; Very strong consistence;
B31	1.1 - 1.3 m	Yellowish red (5YR4/6-Moist); ; Sandy loam; Massive grade of structure; Very strong consistence; Field pH 6.4 (pH meter);
B32	1.3 - 1.5 m	Yellowish red (5YR4/6-Moist); ; Sandy loam; Massive grade of structure; Very strong consistence;
C1	1.5 - 1.7 m	Yellowish red (5YR4/6-Moist); ; Sandy loam; Massive grade of structure; Very firm consistence; Field pH 6.5 (pH meter);

Morphological Notes

Observation Notes

MODERN/HOLOCENE ALLUVIUM:45-88CM SL:VESICULAR:0-15 LATE FLOOD DEPOSIT;

Site Notes

RICHMOND

Project Name: CAN
Project Code: CAN
Agency Name: CSIRO Division of Soils (NSW)
Site ID: CP159
Observation ID: 1

Laboratory Test Results:

Depth m	pH	1:5 EC dS/m	Organic C %	Avail. P mg/kg	Exchangeable Cations Ca	Mg	K	Na	Exchangeable Acidity Cmol (+)/kg	CEC	ECEC	ESP %
0.15 - 0.3	6.2A	0.02A	1.07D	4.7K	4.7K	1.2	0.09	0	6.7B	12.7J		0.00
0.45 - 0.67	6.2A	0.02A	0.62D	4.4K	4.4K	1.3	0.1	0.07	4.2B	10.1J		0.69
0.67 - 0.88	6.2A	0.02A	0.5D	3.5K	3.5K	1.4	0.11	0.07	6B	11.1J		0.63
1.1 - 1.3	6.4A	0.02A	0.21D	2.7K	2.7K	1.6	0.1	0.04	3.2B	7.6J		0.53
1.5 - 1.7	6.5A	0.02A	0.12D	1.9K	1.9K	1.2	0.06	0	1.8B	5J		0.00

Depth m	CaCO3 %	Total P %	Total N %	Total K %	Bulk Density Mg/m3	Particle Size Analysis GV	CS	FS %	Silt	Clay
0.15 - 0.3						3D	60	21	15	
0.45 - 0.67						8D	44	25	23	
0.67 - 0.88						9D	45	23	24	
1.1 - 1.3						17D	46	17	21	
1.5 - 1.7						32D	44	11	13	

Depth m	COLE	Gravimetric/Volumetric Water Contents Sat.	0.05 Bar	0.1 Bar	0.5 Bar	1 Bar	5 Bar	15 Bar	K sat mm/h	K unsat mm/h
		g/g - m3/m3								
0.15 - 0.3										
0.45 - 0.67										
0.67 - 0.88										
1.1 - 1.3										
1.5 - 1.7										

Project Name: CAN
Project Code: CAN
Agency Name: CSIRO Division of Soils (NSW)
Site ID: CP159
Observation ID: 1

Laboratory Analyses Completed for this profile

13_C_FE	Extractable Fe(%) - Method recorded as C
13A1_AL	Oxalate-extractable aluminium
13A1_FE	Oxalate-extractable iron
13C1_AL	Citrate/dithionite-extractable iron, aluminium, Manganese and Silicon
15_NR_CA	Exch. basic cations (Ca++) - meq per 100g of soil - Not recorded
15_NR_CEC	CEC - meq per 100g of soil - Not recorded
15_NR_K	Exch. basic cations (K++) - meq per 100g of soil - Not recorded
15_NR_MG	Exch. basic cations (Mg++) - meq per 100g of soil - Not recorded
15_NR_NA	Exch. basic cations (Na++) - meq per 100g of soil - Not recorded
15G_C_AL1	Exchangeable aluminium - meq per 100g of soil - Aluminium By difference of C and A or B
2A1	Air-dry moisture content
3A1	EC of 1:5 soil/water extract
4A1	pH of 1:5 soil/water suspension
5A2	Chloride - 1:5 soil/water extract, automated colour
6A1_UC	Organic carbon (%) - Uncorrected Walkley and Black method
P10_PB_C	Clay (%) - Plummet balance
P10_PB_CS	Coarse sand (%) - Plummet balance
P10_PB_FS	Fine sand (%) - Plummet balance
P10_PB_Z	Silt (%) - Plummet balance

Figure 9 Plain English Reports generated in NatForm

5.3 Archiving stored specimens

5.3.1 Stock take, labelling and transfer

Archiving of soil specimens increases their accessibility. This process includes stock taking, production of archive-quality, informative labels (based on the soil data in NatSoil), and the transfer of the soil material to a new long-life container. Archiving is a relatively slow process due to the need for careful handling at every stage to maintain quality control. Avoiding confusion, contamination and spillage is imperative in archiving. To archive a sample costs an estimated $20 (at 2011 prices). However, it is the value-adding process of archiving that makes the soil specimens easily accessible. It enables the querying of the soil data in a well-maintained database, which also holds information on the type and amount of soil material for the sample, and on which shelf it can be located.

During stock take, boxes are unpacked (perhaps for the first time in 30 years), and the specimens are sorted and checked for availability. A variety of plastic and cardboard containers, most of which were never intended for long term storage, have been used over the years and many of these have deteriorated with age. Stocktaking, the checking for availability of soil specimens and associated data, is the most time-consuming step of the archiving process. It also involves alignment of the data in the database with the information available on the actual soil specimens (mainly soil depth). Often some specimens have gone missing since a project was concluded. Any such discrepancies between the database and reality are addressed before labels can be produced. Once labels have been produced, the soil material is transferred to new, labelled containers.

Archive labels

Because the cataloguing system of the CSIRO National Soil Archive is based on the database structure, labels are produced as a report in NatSoil. This can only be done after all composite variables have been entered and checked. On every label the following variables of a specimen are shown: *agency, project, observation ID*, *site ID*, horizon (name), depth, *sample* (where there are more specimens per horizon), *layer* and jar. The six italicized variables provide a unique ID for every specimen. The database produces an individual barcode for each archive jar which is a concatenation of these six variables (Figure 10). For added security an identical label is laminated and stored inside the jar. The barcodes enable scanning of labels to help create new Microsoft Access tables of checked-out samples, which can then be easily linked to soil data. When samples are returned after use, the new research results are entered into the database attached to these ID's and entered into the database. This prevents confusion, double labelling and double handling.

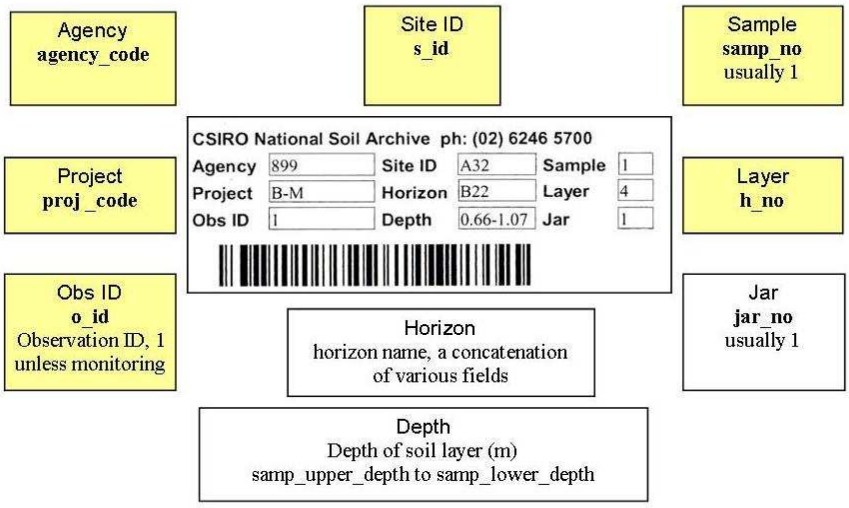

Figure 10 Every specimen is assigned a unique barcode which is a concatenation of the six highlighted variables.

The type of soil material encountered in the original container (fine earth or whole soil, see Figure 11 and 12) and the amount of soil material (the sample is weighed) are noted down and entered in the database table that deals with archiving information (the Archive Samples table).The labelling for each jar consists of an archive-quality, foil-backed adhesive label with essential sample ID information on the outside of the jar, and an identical, but laminated, label inside the jar.

Figure 11 A ‘fine earth’ archived soil specimen

Figure 12 A ‘whole soil’ archived soil specimen

Soil material is always transferred to new, standard archive containers for two reasons: because the old containers are often perishing (plastic food containers, plastic bags, rubber bands) and need upgrading, and to standardise for storage and transport logistics. Where the amount of soil material of a specimen exceeds 1 litre, which is the case for around 15% of specimens, multiple containers are used (jar 1, jar 2 etc). The standard containers used in the archive are long life, high density, stabilised 1 litre poly-ethylene jars. Stabilised jars are used to avoid contamination of the specimen and alteration of soil chemical properties.

After stock take, transfer and weighing, the labelled jars are stacked 4 deep and 3 high on numbered shelves. These shelves are arranged in numbered bays, and each specimen's archive location is entered in the database (e.g. bay 6, rack 3, shelf 2 would be 6-3-2). The resulting collection has a uniform appearance and each sample is easy to access.

5.3.2 Subsampling and scanning

Spectroscopy is a powerful tool for rapid multi-parameter screening of certain soil properties. Soil chemical and physical analyses are time consuming and becoming increasingly expensive. Recent studies (Janik et al., 1998; Viscarra-Rossel et al., 2006; 2010) have demonstrated the utility of NIR and MIR spectroscopy to complement and perhaps one day replace aspects of traditional soil analysis.

Archived soil samples enable the development of national soil diffuse reflectance libraries to characterise soil composition and diversity (pers. comm. Viscarra Rossel). Mid infrared (MIR) and near infrared (NIR) spectroscopy calibrations are being developed from scans of thousands of archived soil samples from around Australia and their chemical and physical soil data as available in the NatSoil database. Current spectroscopic analysis of these soil samples allows researchers to produce digital soil maps of mineral and organic components. In conjunction with this, NIR and MIR will be used to generate results for other analytes that are not part of the original analytical data set. This in turn allows nationwide digital soil mapping of soil properties such as pH, EC, exchangeable cat ions, organic carbon, total nitrogen and physical properties such as soil water holding capacity, particle size analysis and bulk density.

Every sample that is archived at the National Soil Archive is subsampled at the time of for the purposes of building a national spectral library of soils. These 100 ml containers are labelled with an archive style label (Figure 10). Because the spectroscopy scanner cannot read alphanumerics or barcodes, it has been necessary to add a spec-id space on the label. Around 15 gram of soil material is taken from a homogenized soil sample if the soil material is present as 'fine earth', i.e. sieved and coarsely ground to become finer than 2 mm. If the soil material is present as 'whole soil', i.e. unsieved and unground so large aggregates may be present, a representative subsample is taken which is then coarsely ground by mortar and pestle. Subsamples are stored in trays that hold 100 samples in 2 layers of 50. An archive shelf holds 16 trays of subsamples. All subsamples are scanned using NIR. In due course the subsamples will also be finely ground to enable MIR scanning.

Due to the unpredictable presentation of soil material before archiving, it is currently not a feasible proposition to incorporate scanning into the archive process. This is because the processes of stock taking, transfer, grinding and scanning progress at such different speeds; stocktaking and transfer at a rate of 100 samples per day, subsampling at a rate of 60 -100 samples per day, fine grinding at a rate of 50 samples per day and scanning at a rate of 1000 samples per day. For NIR scanning for example, soil material could be passed under the scanner after transfer to the new container and before weighing and storing. However, this would only work if the consistency of the sample was relatively fine (sieved over 2 mm). If this was not the case, coarse grinding would be required before scanning. This would add significantly to the workload, due to the need for cleaning of grinding equipment between every sample (many dozens of cleaning operations per day) and would greatly reduce archiving speed. For MIR scanning, where the subsample needs fine grinding before scanning, incorporation of this process within the archiving procedure is quite impractical.

5.4 Managing requests for specimens and data

When a user request is received the archivists assess the status of the requested soil samples (stored or archived). The database is checked for data availability, amount of soil material available and whether the soil material is finer than 2 mm. The Soil Archive Committee then balances the importance of the planned research and the amount of soil material requested against the amount of soil material available for the needs of future generations, to decide whether the request can be granted. If approval is granted, the archivist accesses and subsamples the required specimens and sends them to the user, at the user's cost of handling and transport. The user will have to sign a form with conditions of use.

A record is kept of which samples are 'in use' and which have been returned. Samples need to be returned within 12 months. Any subsampled soil material remaining after re-analyses have been completed by the user, needs to be returned to the CSIRO National Soil Archive collection (but will stay inside the subsampling container to avoid contamination) as back up soil material. When the sub samples are returned by the user, they need to be accompanied by new research results, as specified in the signed user contract. This new soil data will be added to NatSoil by the database manager. In this way, a small amount of soil material is exchanged for new soil data about this sample and the resources offered to the soil science community continue to grow with use of the CSIRO National Soil Archive.

6. USE OF SOIL SPECIMENS

The CSIRO National Soil Archive balances the preservation of historic soil specimens and associated soil data (for future public research) with the role of making these soil specimens and associated data available for current public research. Potential users of the archived soil specimens must adhere to the Soil Archive policies as a matter of common courtesy and ethical responsibility. If the policies are not followed, the CSIRO National Archive Committee reserves the right to halt further use of the specimens until inconsistencies are solved and guidelines are adhered to.

Access to soil specimens may be provided for research purposes at the discretion of the Steering Committee and is in part dependent on the archive user's past adherence to Archive Policies. Loan requests may be declined, in whole or in part, if the Steering Committee considers the request excessive, disruptive or incompatible with existing or proposed Archive programs, or suspects that specimens might be subject to misuse, damage or deterioration.

6.1 Policy statement

The archived soil specimens have been collected for the purposes of scientific research. Therefore they are expected to be subject to treatments and analytical procedures required to advance science, at the discretion of the CSIRO National Soil Archive Steering Committee, even if this results in consumption or alteration of the specimen. Users need to be keenly aware however, that the quantity of soil material per specimen is limited, and exercise particular restraint when analysis is destructive. To ensure the integrity of the CSIRO National Soil Archive, subsampling is taken very seriously as great care is needed to ensure sufficient material is available for users in future decades. As such our priorities are:

- to maintain the chemical and physical integrity of the specimens;
- to maintain documentary records of the specimens;
- to document the use of the specimens, and promote new research results (e.g. calibration method of new analytical methods, survey of previously measured electrolytes, confirmation of previous measurements);
- to report any changes or factors that affect future use of the specimens (e.g. quantity available, storage conditions, accidents);
- to ensure acknowledgement of used archive specimens in any resulting publications

Though great care is taken to track the data for every specimen, the complete history since sampling is not always known. Some specimens may have been sieved using a brass sieve, which would affect micronutrient analyses.

6.2 Loan Procedure

For detailed information about the specimens in our collection, and their possible availability for further research, contact the CSIRO National Soil Archivist. Arrangements can also be made for browsing and querying the NatSoil database that contains information on all archived specimens. Following the lodging of the User Request Form, the borrower will be provided with a copy of the CSIRO National Soil Archive Policies and be informed on any potential costs.

The CSIRO National Soil Archive Committee reviews the information on the User Request Form. If the request is approved, a user contract is drafted by the Archivist and signed by the borrowing agency.

Subsampling is normally done by archive staff, and the subsamples are sent to the requesting organisation.

The normal loan period is 12 months, but an extension may be granted upon written request. Specimens are not to be forwarded to third parties without advance permission from the Archive.

Both the CSIRO National Soil Archive and the original sources of the collection of soil specimens are to be cited in any publications resulting from research on Archive specimens. Any new research pertaining to the soil archive specimens is added to the NatSoil database to improve the quality of collection.

Any soil material remaining from the specimens must be returned to the Archive as back-up material, with a copy of the user contract, as soon as possible after the completion of the study. These loan specimens should be sent back to the Soil Archive by traceable freight carefully packaged to prevent damage in transit.

Note that loans are made to institutions, not to individuals. The head of the borrowing organisation will take responsibility for the security, interstate quarantine, documentation and safe return of all specimens, and for adherence to the conditions of the loan.

For each loan, a user contract must be signed by both parties. The contract will itemise the materials loaned and analyses to be performed, and state the duration and other conditions of the loan, including limitations of the purpose of the loan, responsibilities of the parties, and options for renewal. It will also form a contract between CSIRO and the borrower's institution. Loans will not be dispatched until the conditions stated in the contract are agreed to.

6.3 Costs of using soil specimens

Organisations may be charged Archive Access Costs of $10 per subsampled specimen, particularly for large user requests, to partially cover the costs of retrieval, subsampling, and material (in 2011 prices). The CSIRO National Soil Archive is a small organisation that holds many tens of thousands of specimens. In many circumstances, the Archive could not provide value-added services free of charge to researchers without reducing the amount of effort going into the archiving of more specimens. It is recommended to budget for Archive Access Costs when planning research based on archived soil specimen.

6.4 Use of soil data only

Access to soil data may be provided for educational and research purposes when approved by the Steering Committee. The CSIRO National Soil Archive has ownership of the data and access to it is at the discretion of the Steering Committee. Use of the information is subject to CSIRO's collaborator and intellectual-property agreements. Upon approval of the data request, data records will be made available through applications developed for search and retrieval of the database. In most cases soil data is provided free of charge where it supports public research.

7. OCCUPATIONAL HEALTH AND SAFETY MANAGEMENT

The main Health and Safety issues that have been identified in the Archive are the hazards of working alone, dealing with dust and noise when transferring soil material, and the lifting of boxes.

Working alone is the main OHS issue in the Soil Archive.
A staff member working alone in the Soil Archive, must wear the alarm button at all times.
A fall from a ladder, a spider bite or fainting in warm weather could be more than injurious than when working around others because it is possible that no one would find the lone worker for many hours. Therefore a VitalCall personal response unit has been installed in the Soil Archive. In case of an emergency, instead of calling out to a colleague, the lone worker simply presses the button on the VitalCall pendant, which has a 100 metre range in open space. A 10 second alert will confirm the call to the VitalCall Response Centre, which will arrange assistance.
CSIRO Working alone policy: (http://intranet.csiro.au/doco/policy/pc2005_06.htm).

Vital Call Information Sheet
To talk to Vital Call, push the red button on the little white pendant (stored on top of PC when not worn), or push the phone button on the white phone unit.
After repeated beeping, VitalCall staff will answer and ask "Do you need help?"
Ask for help if you need it, or tell VitalCall staff that you are okay and just checking the system (which needs to happen once a month). If no answer is received to the question of VitalCall staff ("Do you need help?"), calls will automatically be made to the following numbers to alert them that there is a problem with a worker in the CSIRO National Soil Archive, building 210. After being contacted by VitalCall staff, contacts should check on the person in the archive to see if they are okay.

IF NONE OF THE CONTACTS CAN BE REACHED AN AMBULANCE WILL BE SENT

The telephone number of the analogue line used by the VitalCall system (the incoming number) is **62574868**. To ring VitalCall for other reasons, ring **1300 360 808**.
Note: The VitalCall system has gone off unintended before (with nobody working in the archive and nobody pushing any buttons) when the analogue phone line was disconnected, then came back on.

When working at the dust extractor, staff members must wear ear protectors against the noise.
When transferring soil material the dust extraction unit is used to reduce inhalation of dust and avoid cross contamination of soil specimens.
Also see organisational guidelines: http://intranet.csiro.au/doco/policy/pc2002_12.htm.

When lifting boxes, use correct posture. Do not carry items over 20 kg. Where possible, transport boxes on trolleys to prevent back problems. Manual handling injuries such as back injuries, overuse injuries, sprains and strains are the major contributor to the overall number and cost of injuries in CSIRO, and to the resultant absences of staff from work. CSIRO has placed a high priority on reducing the impact of manual handling injuries arising from its activities and is implementing a focussed injury prevention program - the BOSS (Backs, Overuse, Strains & Sprains) Program. The objective of CSIRO's Policy is to provide guidelines for the prevention of injuries resulting from manual handling tasks or other tasks involving repetition, constrained or awkward posture or excessive force requirements (http://intranet.csiro.au/doco/policy/pc2002_13.htm).

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APPENDIX A: ARCHIVING PROCEDURE

Preparation

- Data entry: all data pertaining to the soil specimens needs to have been entered into NatSoil, e.g. location (latitude and longitude), project information, morphology information, methods of analysis, chemistry results, and other research results.
- Hard copies: field sheets for all specimens to be processed (blue cards or print outs) need to be on hand if available.
- Meeting admittance requirements: all samples need to be air-dried, non-toxic and stored in air-tight containers.

Archiving

- **Setting up**

1. In the NatSoil database, populate the Archive_Samples_table and Samples_table with the new set of soil specimens to be processed, using the Horizons_table and existing queries. This relies on accurate and complete previous data entry.

2. Unpack 3 benches worth of specimens from their boxes, and set them out in profiles for stocktaking.

3. Compare the information from the Samples Table with the information available on the physical soil specimens. Usually there are notes inside the specimen jar, or there is writing on the container or bag.

4. If general agreement exists, use either the qryDepthCentimetre query or the qryDepthInches query to produce a list of specimens, providing a list with depths and specimen names for around 120 specimens. Open this query in ReportCentimetre or ReportInches and print it; this printout is the **identity check list.** It provides a record of stocktaking and is filed after use. The identity check list will eventually show:

   - the presence or absence of specimens
   - the real sampling depths (in case of deviation between database and specimen container)
   - whether the material is present as fine earth (FE) or whole soil (WS)
   - the weight of the soil material (grams)
   - the allocated scanning ID of the subsamples are taken for the development of the spectral library (MIR and NIR scanning).

- **Stocktaking**

  Stocktaking is the archivist's most important job and confusion needs to be avoided above all. Compare each soil specimen with the listed information and take note of any discrepancies. Some common discrepancies between the information in the database and the unpacked soil specimens are listed in the box below. Less common problems may also occur. Solve them as well as possible and check with a pedologist. When in doubt, do not archive. Sort out all discrepancies before proceeding to labelling.

Common discrepancies that come to light during stocktaking

Missing specimens
For example: T126 1,2,3,4,5 and 6 are present, but 7 and 8 are missing.
If the missing specimens cannot be found, check the original blue card or printout with soil profile description. Perhaps 7 and 8 are rocky material.
To reconcile: remove T126-7 and T126-8 from the Archive_Samples_table (database maintenance will also remove the related entries from the Samples table to reflect these changes).

Extra specimens
For example: T238 1 2 3 4a, 4b, 5 and 6. In the database a and b are extremely rare. Check whether 4b would have been renamed 5 and the old 5 now is called 6. Check the original blue card or printout with the soil profile description. Look up the exact depths. Perhaps the b specimen was taken 30 cm more to the east. This may not correlate with lab results and provide reasonable grounds for disposal of the specimen. In general, if there is no documentation for an extra specimen, dispose of it. If it is not in the database, there is usually a good pedological reason for it.
To reconcile: a) dispose of the specimen, or b) archive under a new name - matching real depths (take care!). If a note is included with the soil material, be sure to transfer it as well.

Only go through the considerable effort of entering individual new data to NatSoil if absolutely convinced of the specimen's importance. There are still 25,000 other samples awaiting your attention.

Soil specimen numbers on the old container do not match the specimen numbers in the database
Try to understand why. If the organic top horizons has been sampled, it would not have been entered into NatSoil because pure organic matter is not regarded soil material. If this was the case the organic sample needs to be disposed of.
To reconcile – the process varies, but the most important thing to go on is real depth. It is prudent to dispose of a specimen rather than archive it incorrectly.

Soil horizon numbers on the old container do not match the horizons in the database
Try to understand why. Keeping in mind the structure of the NatSoil database (Horizons_table → Samples_table→ Archive_Samples_table), adjust the Samples_table to match the Horizons_table, and if necessary also adjust the Archive_Samples_table. If several specimens per horizon were sampled, the Archive_Samples_table needs to be manually adjusted to reflect that.

A large amount of soil material is present - When more than one standard 1 litre archive jar of material is available, a second or even third jar may be required. This situation again requires manual adjustments of the Archive Sample Table. Insert a copied record (e.g. T822-2 jar 1) in a new row, and change the jar number to 2. The second jar will have the same barcode because it refers to the same soil sample.

- **Producing labels**

  To ensure consistency, all adjustments to the Archive_Samples_table need to be completed before the labels are produced. Once the identity check list of soil specimens has been made, the actual soil specimens have been laid out in rows and the database is in agreement with the specimens, labels can be produced.

  1. On the identity check list which is used for checking the presence of specimens, their depth and the form in which the soil material is present, add the sequential numbers used for NIR and MIR scanning sub samples. After these unique identifiers have been assigned, enter these Spec ID's to the Archive_Sample_table.

  2. Batches of 40 are practical because 40 large jars fit on a trolley.

3. Adhesive archive labels are made using aBarcode, a third part plug-in for NatSoil, that produces individual barcodes for each sample. The barcode is produced from the data that are also found on the label: *Agency*, *Project*, *Observation ID* (for monitoring purposes), *Site ID*, *Layer and Sample* (where there are more specimens per horizon). Select NatForm and choose the appropriate specimens requiring labels Go to NatForm and choose which specimens you want to produce labels for.

4. The adhesive label paper is foil backed and sourced from a company who specializes in archiving materials; they are claimed to last for 500 years. The label sheets are cut according to our size specifications to accommodate both the project and horizon information and the barcode. Inconsistencies in printing occur occasionally due to poor label cutting, the thick foil-backed paper and uneven printing. The sheets need to be fed to the printer one by one, manually. Printing in batches of ten sheets with constant vigilance minimizes printing errors. Archive sample labels are printed in duplicate (1 sheet with 8 labels in duplicate). The first label is to stick on the jar and the second is to be laminated and stored inside the jar with the specimen, to provide back up labelling. Spec labels, used for the subsamples for spectroscopy scanning, are printed for subsamples and do not require duplication. For the Spec Labels, 16 different labels are printed (1 sheet with 8 labels) as there is no requirement for duplicates.

5. Laminate a couple of batches of labels to have on hand for transferring the soil material. The GBC laminator operates at 110 degrees Celsius at speed setting six. Laminating pouches (150mm) are loaded hinge first, in batches of up to four, to exclude air.

6. Label batch of archive samples jars and the subsamples jars with the appropriate labels.

- **Transferring soil material to new jar and subsampling**

  In the dust extraction unit, carefully transfer the specimen to the pre-labelled archive sample jar and add the laminated label. While the material is being homogenized (shaken) and the jar is still open, carefully subsample 3 teaspoons of the soil material into the 100 ml, labelled subsample jars. Wipe the teaspoon used for subsampling with a clean tissue between each use. The subsamples will be used to build a soil spectral library, using NIR and MIR technology. Place the subsample in the numbered black tray.

  Systematic procedures and vigilant checking minimizes mislabelling or contamination errors throughout the archiving.

- **Weighing**

  When a batch of archive samples has been processed, tare the scales and weigh each archive specimen. Enter the weight of the available soil material on the identity check list. The subsamples do not requiring weighing.

- **Shelving**

  Store the archive samples orderly on the shelves, in the bays, taking note of their location.

  Subsamples are store in numbered trays. Keep track of which trays hold which subsamples by means of tray labels and in the Archive_Sample_table.

- **Updating archive data into NatSoil database**

  Enter the following data from the identity check list into Archive_Samples_table.
  Back up the NatSoil frequently.

  - Soil material type (FE or WS)
  - Location (Isle, Bay, Shelf e.g. 9-2-1)
  - Weight (gram)
  - Stone Fraction (if present, tick box called “>2mm”)
  - Spec ID (Scanning ID)
  - Subsampling date (mm/yyyy)
  - Subsampling tray number

APPENDIX B: HARDWARE

Dexion Key lock Shelving (2438Hx835Dx2591L).
Southern Shop and Office (SSO), 27 Paterson Parade, Queanbeyan NSW 2602
Tel. (02) 62993942

The standard archive jars are 1 litre natural high density polyethylene round jars 95-400 screw neck (40x100) Product no: A572.
The associated lids are 95 mm 400 white polypropylene screw cap – no wad (20x200) lids. Product number 9530
Cospak pty Ltd., 1 Culverston Road, Minto, NSW 2566
Tel. (02) 98207555

The small jars we use for subsamples are 100ml Natural Polypropylene, squat jar, - 63 mm neck (product number C100N)
The associated lids are 63 mm white polypropylene special screw cap for C100N (product number 6244).
Cospak pty Ltd., 1 Culverston Road, Minto, NSW 2566
Tel. (02) 98207555

The small jars are kept in smart black crates 600mm x 400mm x 127 mm (product number AP6411BLK).
Cospak pty Ltd., 1 Culverston Road, Minto, NSW 2566
Tel. (02) 9820 7555

Foil back labels (old) 35x89 mm, 16/sht, pk100. Specimen Box stock code FBL18.
Zetta Florence, PO Box 1173, Collingwood, Victoria, 3066

Foil back labels (new) 35x89 mm, 16/sht, pk 100. Item code LABFB18.
Archival Survival, PO Box 1139, Doncaster East, VIC, 3109
Tel. 1300 781199

Kyocera Mita FS3800N laserprinter

Kyocera Mita FS3700+ laserprinter

Laminator type - GBC 3500 Pro Series serial number QJG2614

Laminating is done using laminating pouch film of 65 x95 millimetres, with a thickness of 150 micrometer - Item 1506595, in boxes of 100 pouches.
GBC Australia, Unit 7, 157 Gladstone Street, Fyshwick, ACT, ACT
Tel. (02) 62808955

APPENDIX C: FORMS

Submission Request Form

The mission of the CSIRO National Soil Archive is to provide facilities and protocols for conserving the long-term scientific value of soil specimens and associated soil data, and to make these specimens and their data available for public research, both now and into the future when new analytical techniques may be brought to bear on the specimens.

The information to be provided below will allow the CSIRO National Soil Archive Committee to review and assess the proposed submission. Please provide the following:

1. Name, Organisation, Address, Email Address and Phone number.
2. How many specimens are to be submitted, from how many sites?
3. How many cubic metres does the collection currently occupy?
4. How many grams of material are available, on average, per specimen?
5. Is the soil material sieved to 2 mm? Does whole soil or coarse fragment materials exist?
6. In what type of airtight containers are the specimens currently held?
7. Are the specimens non-toxic?
8. Are the specimens air- or oven-dried? If oven-dried, to what temperature?
9. In what region were the specimens sampled?
10. Is accurate location information available?
11. Is accurate sampling information available?
12. What analyses were performed? Provide method references.
13. What data are available?
14. In what format is the data currently stored?
15. What data use or licensing requirements are in place, if any?
16. What was the research context?
17. What is the justification for these soil specimens to be part of a national archive?
18. Provide references or copies of published work relevant to the specimens.
19. Is there a quarantine issue associated with transporting the specimens to Canberra?

User Request Form – Soil Specimens

The mission of the CSIRO National Soil Archive is to provide facilities and protocols for conserving the long-term scientific value of soil specimens and associated soil data, and to make these specimens and their data available for public research, both now and into the future when new analytical techniques may be brought to bear on the specimens.

Users of the archive need to be keenly aware that the quantity of specimen is limited and great care is needed to ensure sufficient material is available for users in future decades and centuries.

Therefore we ask that you adhere to our guidelines as a matter of common courtesy and ethical responsibility. If we observe that the guidelines are not being followed, we maintain the right to halt further use of the specimens until inconsistencies are solved and guidelines adhered to. New data acquired pertaining to the soil specimens will need to be made available to the NatSoil database.

The information you provide below will allow the CSIRO National Soil Archive Committee to review and assess your submission. Please provide the following:

1. Name, Organisation, Address, Email Address and Phone number.
2. How many specimens are requested?
3. From which sites, which original sampling agency, which original sampling project, which depth? List or append the results of the NatSoil queries in the following format: Agency, project code, Site ID, Observation ID, Horizon no, Sample no.
4. How many grams of material are requested per specimen? In some cases the requested amount may exceed allowable limits.
5. Choose a preference for either whole soil or fine earth (<2 mm) (if available).
6. For what research do you plan to use these specimens? Append project proposal.
7. List analyses to be conducted and whether they are destructive.
8. Who is responsible for subsampling? For large orders, CSIRO National Soil Archive staff may require assistance by staff of the agency requesting the specimens.
9. Suggest a method of subsampling. Procedure to prevent contamination must be detailed and strictly followed.

User Request Form – Soil Data Only

The mission of the CSIRO National Soil Archive is to provide facilities and protocols for conserving the long-term scientific value of soil specimens and associated soil data, and to make these specimens and their data available for public research, both now and into the future when new analytical techniques may be brought to bear on the specimens.

The information you provide below will allow the CSIRO National Soil Archive Committee to review and assess your submission. Please provide the following:

1. Name, Organisation, Address, Email Address and Phone number.
2. What data is requested?
3. From which sites, which sampling agency, which sampling project, which depth?
4. For what research do you plan to use this data? Append project proposal?

Contact Us

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Email: enquiries@csiro.au

Web: www.csiro.au

Your CSIRO

Australia is founding its future on science and innovation. Its national science agency, CSIRO, is a powerhouse of ideas, technologies and skills for building prosperity, growth, health and sustainability. It serves governments, industries, business and communities across the nation.