# Soil and Regolith Attributes for CRA/RFA Model Resolution Southern Region

A project undertaken as part of the NSW Comprehensive Regional Assessments

September 1999

# SOIL AND REGOLITH ATTRIBUTES FOR CRA/RFA MODEL RESOLUTION

SOUTHERN CRA REGION

NSW Department of Land and Water Conservation, NSW State Forests, NSW National Parks and Wildlife Service, Earth Sciences Foundation and NSW Department of Mineral Resources and Energy

A project undertaken for
the Joint Commonwealth NSW Regional Forest Agreement Steering Committee
as part of the
NSW Comprehensive Regional Assessments.
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The NSW Department of Land and Water Conservation, NSW State Forests, NSW National Parks and Wildlife Service, Earth Sciences Foundation and NSW Department of Mineral Resources and Energy have jointly contributed to providing soil landscape coverage to produce soil/regolith attribute information for the southern CRA region.

Starting in late January 1999 with successful completion in July 1999, this project provides soil attribute data on essential inputs for many modelling projects within the NSW CRA/RFA process (e.g., individual plant and animal species distributions, extent and pre-European distribution of vegetation communities, and site quality and associated fertility of timber resources).

An enhanced Lithological map as well as current versions of soil attribute maps of fertility, soil profile depth, effective rooting depth and estimated plant available water-holding capacity have been generated from 1:100 000 soil landscape coverage and an associated database for the entire Southern CRA area. Soil attribute information can be linked to digital elevation models (DEM's) to produce a higher resolution of soil attributes at 1:25 000 scale. 1296 soil profiles have been described as part of this project and entered into the DLWC NSW Soil and Land Information database. A separate soil landscape coverage has been produced, by merging DLWC's Acid Sulfate Risk Maps with soil landscape mapping, for all coastal sheets. This provides a higher resolution of soil attributes for these areas.

# PROJECT SUMMARY

This report describes a project undertaken as part of the Comprehensive Regional Assessments (CRAs) of forests in NSW. The CRAs provide the scientific basis on which the State and Commonwealth Governments will sign Regional Forest Agreements (RFAs) for major forest areas of New South Wales. These agreements will determine the future of these forests, providing a balance between conservation and ecologically sustainable use of forest resources.

**Project objective/s**
Mapped soil attributes (including depth, fertility and estimated water-holding capacity) and a map of lithology were considered to be fundamental, essential and urgently required inputs to many modelling projects within the NSW CRA/RFA process (e.g., modelling of individual plant and animal species distributions, modelling of extant and pre-European distribution of vegetation communities, and modelling of site quality and associated wood resource attributes).

Prior to this project, soils information was incomplete or non-existent for many areas within the Southern CRA region. The project objective was to expand the existing soil landscape coverage of soil attributes where little or no data was available and develop a mapped coverage of soil attributes across the entire Southern CRA region to assist with CRA vegetation modelling. This included:

- using algorithms previously developed for the north-east CRA project soil attribute and site criteria for collection and ranking of relevant parameters, including fertility, soil depth and soil water-holding capacity;
- fitting of specific soil attributes to existing soil landscape framework;
- extension of the soil and landscape map framework over the remainder of the area; and
- providing potential for greater resolution of soil attributes by making provision for allocation of soil sub-landscapes that can be linked to digital elevation-derived models for outputs at scales of 1:25 000.

**Methods**
Soil landscape coverage for the Southern CRA region was provided from 12 published and draft Department of Land and Water Conservation (DLWC) soil landscape map sheets and the undertaking of extensive reconnaissance level soil landscape surveys for

the remaining 22 1:100 000 map sheets. Additionally, the remapping of the Goulburn and Bathurst 1:250 000 scale soil landscape sheets (to produce seven 1:100 000 scale soil landscape maps) was also undertaken.

Useful data sets including colour air photos, geological and existing soil landscape information were collected and reviewed. 1:100 000 scale base maps showing CSIRO lithology groups, cadastre, contour and thematic mapper images were supplied by NPWS (Queanbeyan). Provisional soil landscape boundaries were drawn onto these base sheets or 1:100 000 topographic sheets using lithology and geology boundaries as well as the interpretation of both colour aerial photography, thematic mapper images and radiometric data. Additional radiometric data was obtained specifically for this project for some coastal areas south of Moss Vale. Free soil survey techniques were used to describe 1296 soil profiles, which were recorded on specially designed CRA soil observation cards. Soil landscape boundaries were refined during fieldwork. Soil data cards were collated and entered into the NSW Soil and Land Information System (SALIS). Algorithms (developed for north-east CRA) were used to assess specific soil attributes (soil fertility, soil depth, effective rooting depth, drainage and estimated plant available water-holding capacity) from existing soil profiles, Southern CRA soil profiles and information in existing soil landscape reports. Soil landscape descriptions including assessment of soil attributes for each soil sub-landscape were entered into a specially designed Access database. Field maps were traced, edge matched and checked along with corresponding unit descriptions in the database and sent to NPWS for scanning and linking of specific soil attributes to the soil landscape coverage.

Enhanced resolution of the soil attribute information can be undertaken by the use of digital elevation models to delineate soil sub-landscapes based on Compound Topographic, Elevation, Aspect and Solar Radiation Index, and linking these with soil landscape attributes in the database. NPWS and Bureau of Rural Sciences (BRS), Canberra will use this coverage for vegetation modelling purposes.

**Key results and products**

A seamless coverage of the current version of soil attribute themes including fertility, soil profile depth, effective rooting depth and estimated plant available water-holding capacity have been generated over the entire Southern CRA area using soil landscape mapping with an associated Access database. Additionally, a separate soil landscape coverage of the coastal map sheets has been compiled on request from NPWS by merging DLWC 1:25 000 scale Acid Sulfate Risk Maps with the Southern CRA coverage for these areas. An improved, more detailed lithology coverage was also produced based on the 1:100 000 soil landscape mapping, which will assist vegetation modelling.

# 1. INTRODUCTION

## 1.1 BACKGROUND

The Comprehensive Regional Assessment Southern Unit (SCRA) of National Parks and Wildlife Service (NPWS) approached the Department of Land and Water Conservation (DLWC) in September 1998 regarding the availability of soil information to assist with vegetation modelling across the CRA Region and to review a draft proposal for lithology mapping submitted to the CRA Environment and Heritage Technical Committee. Various outputs from the modelling process will provide base information for the Regional Forestry Assessment (RFA) process. Mapped soil attributes were required as inputs to a number of modelling projects, including modelling of individual flora and fauna distributions, extent of pre-1750 vegetation communities, and site quality and associated wood resource attributes.

Prior to this project, the only soil/regolith information available was partial 1:100 000 and 1:250000 scale soil landscape coverage and a very broad composite map of lithology groups derived from 1:250 000 geological maps compiled by CSIRO. None of these provided a complete, accurate medium- to high-resolution soil/regolith map necessary for vegetation modelling purposes. In particular, the distribution of soil attributes such as an estimation of soil fertility, soil drainage, effective rooting depths (ERD) and estimated plant available water-holding capacity (EPAWC) were considered essential parameters for effective vegetation modelling.

To ensure soil attribute data was included in the modelling process, coverage for coastal high priority areas was required by NPWS by the end of March 1999, and for the remainder of the area, by the end of April 1999. Considering the tight timeframes and limited budget for the Southern CRA project, the only way to provide complete detailed coverage of these attributes within the timeframe was to assess existing published and draft soil landscape maps and reports, and to undertake a reconnaissance level soil landscape survey over the remaining area. It was also requested that provision be made for soil attributes to be linked to more detailed digital terrain models (e.g., compound topographic indexfor outputs at higher resolution (to 1:25 000)) for use in the RFA modelling process.

Considerable progress had been made in refining digital mapping of other abiotic attributes across all CRA regions, such as terrain attributes derived from a 1:25 000 Digital Elevation Model (DEM) and linking with climate attributes such as solar radiation and climate estimation via the Estimate of Climate Program

(ESOCLIM). However, mapped coverage of soil attributes was limited to several published soil landscape maps undertaken by DLWC.

Predictive modelling of soil attributes has been shown to be a cost-effective means of improving the resolution and coverage of soil attribute mapping within the narrow CRA timeframe. The approach is based on work undertaken by McKenzie and Austin (1993); Moore *et al.* (1993); and Gessler *et al.* (1995), which involved the modelling of soil attributes recorded at field survey sites within each mapped parent material, climatic and topographic class (or soil landscape if available), in relation to fine-scaled terrain and climate variables derived from digital elevation models.

This project covers the original Southern CRA project area as specified in the approved project proposal. Subsequent modifications were made to the CRA boundary to include more land outside the original project area. DLWC is only responsible for the assessment and coverage of soil/regolith attributes of the original CRA area. BRS has undertaken an extrapolation of data to fill the gaps created by the revised CRA southern region boundary.

The proposal was developed by Greg Chapman (DLWC) and Nick Gellie (NPWS), building on an existing NPWS proposal.

A steering committee guided the process. It included representatives from State Forests, DLWC, NPWS, Earth Sciences Foundation and Department of Mineral Resources and Energy.

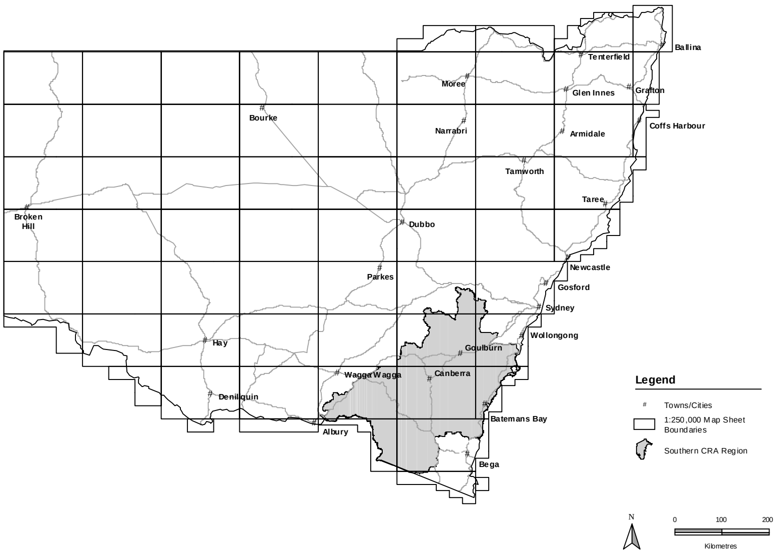
# 2. METHODOLOGY

## 2.1 SCOPE OF PROJECT

The project required DLWC to provide a complete soil/regolith attribute coverage of Southern CRA through existing soil landscape information and also by undertaking new soil landscape mapping. This included supplying important soil attributes to the RFA modelling process including soil fertility, soil drainage, soil depth, effective tree rooting depth and estimated plant available water-holding capacity, through soil landscape mapping. The potential to provide soil attributes at resolutions approaching 1:25 000 scale was made available through the generation of soil sub-landscape level soil attribute data which, if required, could be linked with digital elevation models.

The SCRA region (Figure 2a) covers extensive areas of south-east NSW including much of the coast in the east; the southern tablelands below Oberon in the north; most of the southern highlands to the Victoria border in the south; and some of the south-west slopes to the Hume Highway in the south-west. It excludes the Eden region in the south-east.

**FIGURE 2A: LOCATION OF SOUTHERN CRA PROJECT AREA**

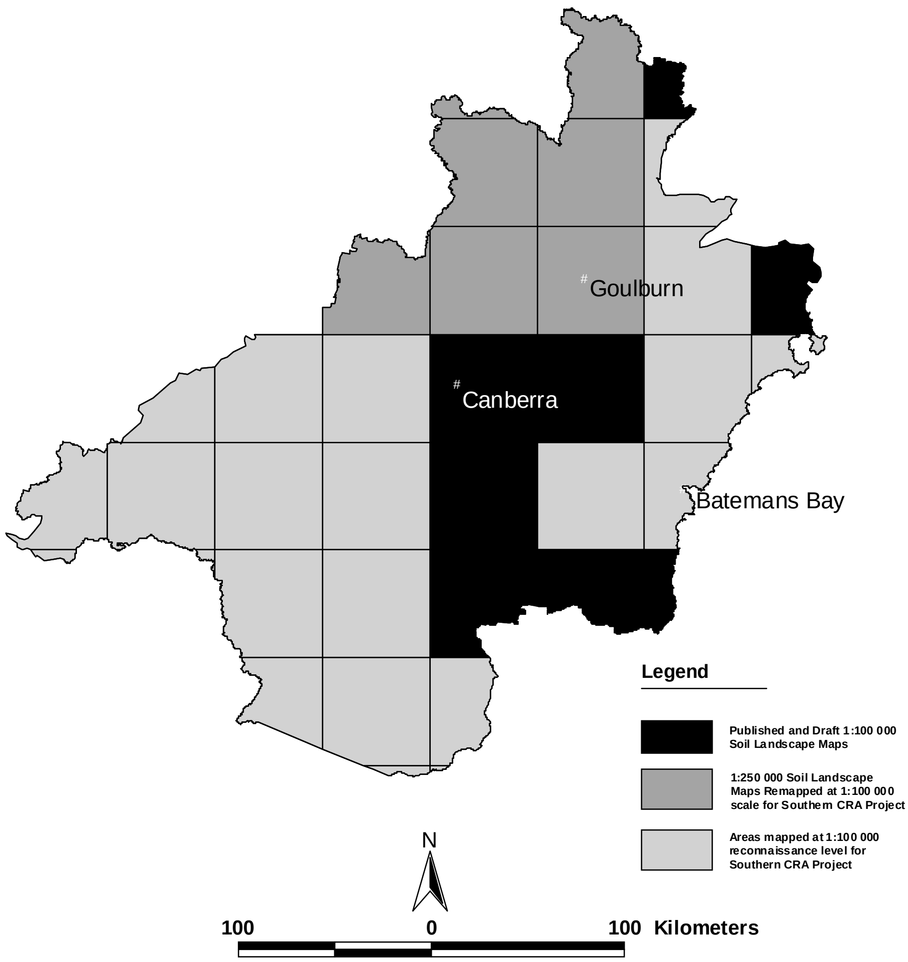


Existing digital coverage and soil landscape information was available for 12 published and draft 1:100 000 scale soil landscape maps (Table 2a). Reconnaissance level 1:100 000 scale soil landscape mapping was undertaken for the remaining 22 1:100 000 maps sheets, including the remapping of the Bathurst and Goulburn 1:250 000 sheets at 1:100 000 scale. The data source diagram below (Figure 2b) shows the distribution of draft and published sheets as well as where new reconnaissance level soil landscape mapping was undertaken for this project.

**TABLE 2A: LIST OF PUBLISHED AND DRAFT SOIL LANDSCAPE MAPS AND REPORTS USED IN THE PROJECT**

| DLWC Soil landscape sheet | Publication status at time of project | Reference |
|---|---|---|
| Bathurst 1:250 000 sheet | Published | M.Kovac, B.W. Murphy and J.W. Lawrie 1990 |
| Braidwood 1:100 000 sheet | Published | B.R. Jenkins 1996 |
| Canberra 1:100 000 sheet | Draft | B.R. Jenkins (in prep.) |
| Cobargo 1:100 000 sheet | Draft | M.J.Tulau (in prep.) |
| Cooma 1:100 000 sheet | Published | M.J.Tulau 1994 |
| Goulburn 1:250 000 sheet | Published | C.Hird 1990 |
| Holbrook-Tallangata 1:100 000 sheet | Draft | D. Hopman (in prep.) |
| Katoomba 1:100 000 sheet | Published | D.P. King 1994 |
| Kiama 1:100 000 sheet | Published | P.A. Hazelton 1992 |
| Michelago 1:100 000 sheet | Published | B.R. Jenkins 1996 |
| Narooma 1:100 000 sheet | Draft | M.J.Tulau ( in prep.) |
| Tarcutta 1:100 000 sheet | Draft | J. A. Wild (in prep.) |

**FIG 2B: SOIL LANDSCAPE MAPPING DATA SOURCE DIAGRAM**




Soil landscapes are defined as "*areas of land that have recognisable and specifiable topographies and soils, that are capable of presentation on maps, and can be described by concise statements*" (Northcote 1978). The mapping of landscape properties can be used to distinguish mappable areas of soils because similar causal factors are involved in the formation of both landscapes and soils. Through remote sensing, interpretation of landscape features and the description of soils in the field, a soil landscapes model can be built that predicts the distribution and occurrence of different soil types within each landscape. Different soil types have different soil attribute properties and these can often be linked to digital elevation based models for higher resolution of soil attributes.

It is important to note that this mapping is of a reconnaissance level only and should only be used as a guide to the distribution of specific soil attributes identified for the purposes of this project.

Additionally, NPWS requested DLWC to provide a separate soil landscape coverage for the coastal sheets using the DLWC 1:25 000 scale Acid Sulfate Soil Risk Maps.

Reconnaissance level soil landscape mapping was undertaken at 1:100 000 scale to re-map the existing 1:250 000 Goulburn and Bathurst sheets and to provide soil attribute coverage via soil landscape mapping over the remaining areas, where no previous soil landscape information existed.

## 2.2 SETTING GOALS, TIMEFRAMES AND METHODOLOGY

Prior to project approval, several steering committee meetings were held to consider the project strategy and contents of the proposal, roles, etc. It was decided that DLWC would have the main carriage of the project, with NPWS supplying special base maps and being responsible for scanning of maps and linking the soil attribute data to the soil landscape coverage created. Department of Mineral Resources and Energy and Earth Sciences Foundation were responsible for providing radiometric and magnetics data for use in the project. Each of the parties involved were satisfied with the outcomes of the project proposal.

Shortly following the SCRA project approval in January 1999, a meeting took place with NPWS, soil surveyors from the recently completed north-east soil and regolith attribute CRA project, and proposed soil surveyors for the Southern CRA project, to discuss ways of improving the methodology for Southern CRA. Following this meeting, specifications for the SCRA project were drawn up to provide detailed guidelines for soil surveyors to follow regarding methodology, timeframe and outputs required for the project.

A further technical meeting was held at Queanbeyan in January 1999 to disseminate and discuss the project specifications with key DLWC and NPWS staff. A field trip was also organised to ensure soil surveyors were familiar and consistent in data recording of specific soil attributes in the field (e.g., calculation of effective rooting depth).

NPWS defined timeframes for required outputs for high and low priority areas (see Table 2b below). Outputs were required as traced copies of 1:100 000 field sheets for scanning by NPWS consultants and providing matching data sets of soil attributes. Coastal high priority sheets were to be produced first.

The project steering committee identified the high priority areas of Moss Vale and coastal areas as warranting the collection (by air) of radiometric and magnetic data. This coverage was expected to be extremely useful in interpreting complex geology and soil types in these areas.

**TABLE 2B: SCHEDULE AND PRIORITY OF SOUTHERN CRA MAP SHEETS**

| 1:100 000 Map Sheet | Priority | Maps and Data to NPWS ‘99 |
|---|---|---|
| Araluen | H | 8th March |
| Batemans Bay | H | 8th March |
| Bendock | H | 9th April |
| Berridale | L | 9th April |
| Blayney | L | 9th April |

| | | |
|---|---|---|
| Bombala | L | 9th April |
| Braidwood | L | 9th April |
| Brindabella | H | 9th April |
| Burragorang | H | 9th April |
| Cobargo | H | 8th March |
| Cooma | L | 9th April |
| Craigie | L | 9th April |
| Crookwell | L | 9th April |
| Goulburn | L | 9th April |
| Gunning | L | 9th April |
| Holbrook | H | 9th April |
| Jacobs River | L | 9th April |
| Jervis Bay | H | 8th March |
| Katoomba | L | 9th April |
| Kiama | H | 8th March |
| Kosciusko | L | 9th April |
| Michelago | L | 9th April |
| Moss Vale | H | 9th March |
| Narooma | H | 8th March |
| Numbla | H | 9th April |
| Oberon | L | 9th April |
| Rosewood | H | 9th April |
| Tallangatta | H | 9th April |
| Tantangara | L | 9th April |
| Taralga | L | 9th April |
| Tarcutta | H | 9th April |
| Tumut | H | 9th April |
| Ulladulla | H | 8th March |
| Yarrangobilly | H | 9th April |
| Yass | L | 9th April |

H= high
L= low

## 2.3 PROJECT TASKS

To undertake such an extremely large soil landscape mapping and soil attribute assessment project within the tight CRA timeframe, a number of tasks were implemented to ensure the project followed an orderly path to achieve its goals. Soil surveyors were allocated previously unmapped 1:100 000 map sheet areas. One month of soil surveyor time was allocated to produce each high priority sheet; three weeks for producing low priority sheets; and one week to remap the existing 1:250 000 scale soil landscape sheets at 1:100 000 scale. Within this period, soil surveyors had to undertake remote sensing and air photo interpretation, field work and field data collection, map unit descriptions, calculation of required soil attribute parameters, edge-matching with adjacent map sheets and finally, tracing and tagging a copy of their field sheets for scanning.

### 2.3.1 Task 1 - Establishing map units

A map unit code string (Table 2c) was devised that ensured soil surveyors were describing and mapping similar soil landscape properties and allowing an updated lithology coverage to be generated. The map unit string contains 11 alphanumeric characters and consists of province code, lithology code, landform relief/modal slope code, landform attribute or element code and finally, soil landscape code. Only the last three characters of the soil landscape code were entered on the maps.

Each of these long string map unit codes are unique within the Southern CRA region.

**TABLE 2C : MAP UNIT LAYOUT**

| Province Number (1 - 6) | Lithology Code (2-letter lower case) | Landform Relief Modal slope (2-letter lower case) | Landform Attribute or Element (3-letter lower case) | Soil Landscape code (3-letter lower case) |
|---|---|---|---|---|
| 4 | sl | gu | hil | soz |

## Provinces

The CRA region was split into a number of provinces to provide a broad picture of the main types of country soil surveyors were to undertake soil survey in. Six broad provinces were identified and drawn onto copies of the 1:100 000 base maps as a guide for soil surveyors who had to allocate a number to each soil landscape unit description. These were:

1 = Coastal Lowlands
2 = Coastal Ranges
3 = Sydney Basin
4 = Tablelands
5 = Highlands
6 = Western Slopes

## Lithology Code

Lithology maps by CSIRO were updated by soil landscape mapping through the allocation of a two-letter lithology code to each map unit. Table 2d shows the relationship of these codes with the CSIRO lithology codes supplied by NPWS. Furthermore, it was recognised that unconsolidated sediments (parent materials) could be further sub-divided into colluvium, aeolian and alluvial sediments, which would enhance the lithology maps for vegetation modelling.

**TABLE 2D: CONVERSION TABLE BETWEEN CSIRO LITHOLOGY KEY AND THE LITHOLOGY MAP KEY USED**

| **CSIRO Map Code** | **CSIRO Lithology** | **DLWC Lithology Key** |
|---|---|---|
| 1 | Coastal Beach Deposits | ma (marine) |
| 2 | Metamorphic: Medium-High Grade | me |
| 3 | Plutonic: High Alkaline Feldspar | ph |
| 4 | Plutonic: Low Alkaline Feldspar | pl |
| 5 | Plutonic: Medium Alkaline Feldspar | pm |
| 6 | Sedimentary: High Quartz | hs |
| 7 | Sedimentary: Limestone | li |
| 8 | Sedimentary: Low Quartz | ls |
| 9 | Unconsolidated Sediment | al (alluvial)<br>cl (colluvium)<br>ae (aeolian) |
| 10 | Under Permanent Water | |
| 11 | Volcanic/Hypabyssal: Intermediate-Acid | va |
| 12 | Volcanic/Hypabyssal: Ultrabasic-Basic | vb |

### Landform pattern relief modal slope code

Landform relief/modal slope two-letter codes were applied based on those listed and described in the *Australian Soil and Land Survey Field Handbook* (McDonald *et al.* 1990). Examples include **ur** - undulating rises; **sh** - steep hills; and **pm** - precipitous mountains.

### Landform attribute or landform element code

These three-letter codes stand for attributes of landform patterns or elements and are listed and described in the *Australian Soil and Land Survey Field Handbook* (McDonald *et al* 1990). These were used to further divide similar landform patterns. ***Attributes*** of landform patterns cover such things as **hil** - hills, **san** - sandplain, **alp** - alluvial plain and **dun** - dunefield. Where significant, ***landform elements*** were mapped, e.g., **hcr** - hillcrest, **hsl** - hillslope, **foo** - footslope, **bri** - beachridge and **tal** – talus, etc.

### Soil Landscape code

Soil landscapes were used to discriminate different soils by distinguishing landscape features (especially those important to vegetation modelling). Each soil landscape was given a three-letter code. This allowed the inclusion of published two-letter soil landscape codes (e.g., *mu* from the local geographic name Murrah ) and their variants with three letter codes (e.g., *mua*) to be given the same length character code. Also, a soil landscape was allocated the letter *z* by default, so as to retain the three-letter code system (e.g., *mu* would become *muz*). A soil landscape variant usually has a different property than the parent soil landscape, e.g., shallower soils, but generally all other soil landscape features are similar. The letter *a* is used to identify the first soil landscape variant of the parent soil landscape. Any subsequent variants were given alphabetically ascending postscripts (e.g., *b*, *c*, *d*, etc.). This three-letter code was placed on the traced field maps. Although not mutually exclusive, the code was linked in the database to the long map unit string code, which was unique and ensures that each soil landscape is linked to appropriate data in the database.

**Example of a long string map unit code.** The map unit code *3vbrhfoosoz* would be used to define a map unit on the *coastal lowlands* province with *volcanic basic* lithology, a *rolling hills* local relief modal slope class, a *footslope* landform element and an *soz* soil landscape code. This long string code is unique in the Southern CRA.

### 2.3.2 Task 2 - Review and acquire existing data

The second task undertaken was to search for and review all existing information that would assist in undertaking the project. This included the acquisition of:

- Existing radiometric and magnetic coverage, where available. Additionally, radiometric and magnetic data was collected and analysed for the Moss Vale an coastal areas relevant published soil landscape maps and reports with digital coverage

- 1:250 000 geology and lithology maps and associated information
- 1:25 000 scale colour aerial photographs for Aerial Photograph Interpretation
- 1:100 000 scale topographic maps
- 1:100 000 scale base maps from NPWS (Queanbeyan) with CSIRO lithology boundaries and codes, relevant cadastral information and a satellite Landsat TM wash-out in the background

### 2.3.3 Task 3 - Methodology for the calculation of key soil attributes.

Key soil attributes for CRA modelling, namely soil fertility, soil drainage, effective rooting depth and estimated soil water-holding capacity were identified and developed during the upper north-east and lower north-east CRA projects.

The second task was to develop a methodology for assessing the soil attributes required for vegetation modelling. The following outlines the methodology used to assess soil attributes within every soil sub-landscape (partition of the soil landscape) for both existing soil landscape information and new reconnaissance soil landscape mapping.

**Modified Fertility Class**

Five soil fertility classes (see Table 2e) were originally derived, based on the soil's *Great Soil Group* classification (Stace *et al*. 1968) as outlined in *Soils of New South Wales-Their Characterisation, Classification and Conservation* (Charman 1978). A class of "1" indicates a soil of very low fertility, while a class of "5" indicates a soil with high fertility. ***Modified soil fertility classes*** were evaluated based on this table and fertility classes were raised or lowered due to positive or negative soil fertility attributes present which differed markedly from the nodal soil description. For example, a soil sub-landscape such as a crest with a stony, shallow Red Podzolic Soil has a fertility class of 3 (see Table 2), but this classification can be downgraded to a modified fertility class of 2 due to the stoniness and shallowness of the soil profile. Thus, the modified fertility class of this soil is 2. Conversely, a soil's modified fertility class may be improved if the soil had positive soil fertility properties such as good depth, good drainage and high organic matter content in the topsoil.

**TABLE 2E: FERTILITY CLASSES OF GREAT SOIL GROUPS (AFTER CHARMAN 1978)**

| Great Soil Group | Fertility Class | Great Soil Group | Fertility Class |
|---|---|---|---|
| Solonchak | 1 | Non-calcic Brown Soils | 4 |
| Alluvial Soil | 5 | Chocolate Soil | 4 |
| Lithosol | 1 | Brown Earth | 3 |
| Calcareous Sand | 1 | Calcareous Red Earth | 2 |
| Siliceous Sand | 1 | Red Earth | 3 |
| Earthy Sand | 1 | Yellow Earth | 2 |
| Grey-brown Calcareous Soil | 1 | Terra Rossa Soil | 3 |
| Red Calcareous Soil | 1 | Euchrozem | 4 |
| Desert Loam | 1 | Xanthozem | 3 |
| Red and Brown Hardpan Soil | 1 | Krasnozem | 4 |
| Grey Clay | 3 | Grey-brown Podzolic Soi | 2 |

| | | | |
|---|---|---|---|
| Brown Clay | 3 | Red Podzolic Soil | 3 |
| Red Clay | 3 | Yellow Podzolic Soil | 2 |
| Black Earth | 5 | Brown Podzolic Soil | 3 |
| Rendzina | 3 | Lateritic Podzolic Soil | 1 |
| Chernozem | 5 | Gleyed Podzolic Soil | 3 |
| Prairie Soil | 5 | Podzol | 2 |
| Wiesenboden | 3 | Humus Podzol | 2 |
| Solonetz | 2 | Peaty Podzol | 2 |
| Solodized Solonetz | 2 | Alpine Humus | 3 |
| Solodic Soil | 2 | Humic Gley | 2 |
| Soloth ( Solod) | 2 | Neutral Peat | 2 |
| Solonized Brown Soil | 2 | Alkaline Peat | 2 |
| Red-brown Earth | 4 | Acid Peat | 1 |

**Drainage**
Five drainage classes were defined, based on the classes recorded on the NSW SALIS soil data cards (Abraham & Abraham 1992; McDonald *et. al*. 1990). They are:

1. very poorly drained
2. poorly drained
3. imperfectly drained
4. moderately well-drained
5. well-drained

**Effective Rooting Depth (ERD)**
This is an estimate of the soil and substrate available for tree roots to penetrate and is an important factor in the calculation of estimated plant available water-holding capacity (EPAWC). Where the parent material was not fractured, or where an impeding layer for tree roots exists (e.g., pan or rock), then an estimate of ERD was undertaken on the average depth in the soils and regolith that tree roots are likely to penetrate. This is the effective rooting depth. Where the parent material is fractured, tree roots will be able to penetrate both the solum and, to some extent, weathered parent material. To calculate the ERD:
1. estimate the size, depth and number of fractures in the parent material and estimate an **average** depth that roots will be able to penetrate;
2. **add** this to the depth of the solum; and
3. **subtract** the Fragment Amount volume (see below) from the final calculation to get the effective rooting depth.

*Example:*
The soil depth is **1.2 m**, fragment amount is **10%**. The substrate is *fractured*, so roots will penetrate the substrate. The depth of the substrate to which the roots will penetrate is estimated to be **2.5 metres**, but only **20%** of the substrate volume is available (i.e., cracks, etc.).

ERD = soil depth + (substrate volume available to roots % x root penetration into substrate) **-** (fragment amount % x soil depth)

ERD = 1.2 m + (20% x 2.5 m) - (10% x 1.2 m) = 1.58 metres

**Estimated Plant Available Water-holding Capacity (EPAWC)**

This is an estimation of a soil's capacity to store water for use by plants. It is based on methodology outlined by Greacen and Williams (1983) with reference to work undertaken by Salter, Berry and Williams (1966); and Salter and Williams (1963, 1965, 1967, 1969), which outline the strong relationship between soil texture and available water-holding capacity. This has been modified to improve the values by 20% for soils with very fine structure or with very high organic matter content on the basis of data held in DLWC Soil and Land Information System (SALIS). The original data set used by Greacen and Williams was based on agricultural soils and did not take into account strongly and finely structured forest soils.

The EPAWC of a soil profile is calculated by multiplying the soil texture EPAWC (Table 2f) by the soil structure factor (1.2 for finely structured forest soils), which is multiplied by the horizon thickness in metres. This is repeated for each horizon inside the estimated rooting depth. The EPAWC for the soil profile is the sum of EPAWC calculated for all layers.

**TABLE 2F: PLANT AVAILABLE WATER-HOLDING CAPACITY (PAWC) VALUES FOR TEXTURE GRADES (MODIFIED FROM SALTER & WILLIAMS 1967, 1969; GRACEN & WILLIAMS 1983; AND HAZELTON & MURPHY (1992)**

| TEXTURE | PAWC (mm of water stored per m of soil) | TEXTURE | PAWC (mm of water stored per m of soil) |
|---|---|---|---|
| Sand | 150 | heavy clay loam | 180 |
| coarse sand | 80 | clay loam, coarse sandy | 170 |
| fine sand | 200 | clay loam, sandy | 175 |
| loamy sand | 160 | light clay loam, sandy | 175 |
| loamy coarse sand | 108 | heavy clay loam, sandy | 175 |
| loamy fine sand | 217 | clay loam, coarse sandy | 170 |
| clayey sand | 150 | light clay loam, coarse sandy | 170 |
| light clayey sand | 150 | heavy clay loam, coarse sandy | 170 |
| heavy clayey sand | 150 | clay loam, fine sandy | 190 |
| clayey coarse sand | 80 | light clay loam, fine sandy | 190 |
| light clayey coarse sand | 80 | heavy clay loam, fine sandy | 190 |
| heavy clayey coarse sand | 80 | silty clay loam | 190 |
| clayey fine sand | 215 | light silty clay loam | 190 |
| light clayey fine sand | 215 | heavy silty clay loam | 190 |
| heavy clayey fine sand | 215 | light silty clay loam, fine sandy | 195 |
| sandy loam | 180 | sandy clay | 140 |
| light sandy loam | 180 | sandy light clay | 140 |
| heavy sandy loam | 180 | sandy light-medium clay | 140 |
| coarse sandy loam | 125 | sandy medium clay | 140 |
| light coarse sandy loam | 125 | sandy medium-heavy clay | 140 |
| heavy coarse sandy loam | 125 | sandy heavy clay | 140 |
| fine sandy loam | 192 | coarse sandy clay | 130 |
| light fine sandy loam | 192 | coarse sandy light clay | 130 |
| heavy fine sandy loam | 192 | coarse sandy light-medium clay | 130 |

| | | | |
|---|---|---|---|
| loam | 180 | coarse sandy medium clay | 130 |
| loam,fine sandy | 185 | coarse sandy medium-heavy clay | 130 |
| silty loam | 200 | coarse sandy heavy clay | 130 |
| light silty loam | 200 | fine sandy clay | 150 |
| heavy silty loam | 200 | fine sandy light clay | 150 |
| sandy clay loam | 150 | fine sandy light-medium clay | 150 |
| light sandy clay loam | 150 | fine sandy medium clay | 150 |
| light-medium sandy clay loam | 150 | fine sandy medium-heavy clay | 150 |
| medium sandy clay loam | 150 | fine sandy heavy clay | 150 |
| heavy sandy clay loam | 150 | silty clay | 183 |
| coarse sandy clay loam | 140 | silty light clay | 183 |
| light coarse sandy clay loam | 140 | silty light-medium clay | 183 |
| light-medium sandy clay loam, coarse sandy | 140 | silty medium clay | 183 |
| medium sandy clay loam,coarse sandy | 140 | silty medium-heavy clay | 183 |
| heavy coarse sandy clay loam | 140 | silty heavy clay | 183 |
| fine sandy clay loam | 180 | Clay | 180 |
| light fine sandy clay loam | 180 | light clay | 180 |
| heavy fine sandy clay loam | 180 | light-medium clay | 180 |
| clay loam | 180 | medium clay | 180 |
| light clay loam | 180 | medium-heavy clay | 180 |
| medium-heavy clay loam | 180 | heavy clay | 180 |

### 2.3.4 Task 4 - Setting up the database to store soil landscape and soil attribute information

A main central database was set up to correlate, store and keep track of the huge amount of soil landscape information collected by the numerous soil surveyors around the State. A central Microsoft 2.0 Access Database was set up to enable the entry, storage, manipulation and quality control of soil landscape information. A user-friendly data entry screen with drop-down buttons for many attributes ensured that consistent information was entered, reducing the capacity for error generation. The data entry screen is linked to separate soil landscape and sub-landscape tables, which allow ready export and linking with other databases and GIS packages. Soil surveyors were given copies of the database, which was to be filled in following fieldwork and added to the main central database. This allowed the data to be readily verified and controlled at a single location. The following table (Table 2G) provides a list of the information recorded in the database for each soil landscape.

**TABLE 2G: SOIL AND LANDSCAPE PROPERTIES RECORDED FOR EACH SOIL LANDSCAPE UNIT IN THE ACCESS DATABASE**

| Database attribute | Description |
|---|---|
| Soil Landscape Code | three-letter soil landscape string, which occurs on the maps. It is not unique and the code can occur on numerous map sheets, but is |

| | |
|---|---|
| | linked to the soil landscape string and secondary map sheet units, which identifies the correct dataset in the database |
| Soil Landscape String | eleven-character string contains code information for province, lithology, relief/modal slope class, landform attribute or element and soil landscape/soil landscape variant code. It is unique in the database |
| Completed by | identifies the person responsible for the entry of the soil landscape into the database |
| Map sheet name | name of the 1:100 000 map sheet, e.g., Kiama |
| Map sheet number | topographic 1:100 000 map sheet number e.g., 9027 |
| Secondary map sheet | other topographic map sheet numbers on which the soil landscape occurs |
| Province number | one of six province codes is entered. Makes up part of landscape string (see 2.2.3 for details) |
| Lithology code | DLWC lithology codes (see 2.2.3 for details) |
| Landform relief code | landform relief modal slope class entered (see 2.2.3 for details) |
| Landform attribute or element class | landform attribute element class (see 2.2.3 for details) |
| Main correlating factor | factor used to link soil sub-landscapes (see below) to digital elevation models for enhanced resolution of soil attributes. Includes choice of compound topographic index, elevation, aspect and solar radiation index |
| Soil Regolith class | soil regolith stability classification after Murphy, Fogarty and Ryan (1998) classifies the stability of a soil for forestry uses into four classes. Class 1 is stable coherent soils with low sediment delivery potential to streams. Class 2 is non-coherent sandy soils with low sediment delivery. Class 3 is coherent soils with high sediment delivery. Class 4 is non-coherent soils with high sediment delivery potential. |
| Geology/lithology | the geology code or CISRO lithology code (optional) |
| Slope range | slope range for the soil landscape |
| Average slope | average slope for the soil landscape |
| Relief | relief of the soil landscape |
| Description of topography | description of topography (optional) |
| Rock outcrop | % of rock outcrop in soil landscape |
| Other distinguishing features | other features not previously recorded that help define the soil landscape (optional) |
| Elevation range | elevation range (in metres) of the soil landscape |
| Vegetation community | dominant vegetation community in soil landscape |
| Land use | dominant land use is listed |
| Type location | location of a typical site for the soil landscape |
| Limitations | major soil and landscape limitations that are likely to be present and pose restrictions to urban and rural activities. |
| Notes | notes on the soil landscape (optional) |
| Soil sub-landscape code | 12-character string code (the soil landscape 11-character string with an extra number added as a postscript and starting with the number 1 and increasing consecutively for each new soil sub-landscape present) e.g., 3vbrhfoosoz1 is the first soil sub-landscape in the map unit 3vbrhfoosoz landscape. Every soil landscape has at least 1 and generally <= 4 soil sub-landscapes |
| soil sub-landscape description | a soil sub-landscape is a partition of a landscape that assists in defining the allocation of different soil types (and soil attributes) in a soil landscape. It is based on compound topographic index, solar radiation, aspect or elevation or none. A description of the soil sub-landscape is provided, e.g., crest, sideslope, footslopes, drainage line |
| % of soil landscape | the average % of area which the soil sub-landscape covers |
| Aspect | the aspect of the soil sub-landscape is provided if applicable |
| Mean estimated soil depth | the mean estimated soil depth is entered for each soil sub-landscape (see 2.3.2 for details) |
| Mean estimated effective rooting depth | mean estimated effective rooting depth, i.e., the volume of soil/voids in substrate that are accessible by tree roots is provided (see 2.3.2 for details) |
| Mean modified fertility | mean modified fertility class for each soil sub-landscape if given |

| | |
|---|---|
| | (see 2.3.2 for details) |
| Estimated plant available water-holding capacity | plant available water-holding capacity estimates are provided for each soil sub-landscape (see 2.3.2 for details) |
| Mean drainage | mean drainage class of the soil sub-landscape |
| Confidence level | the level of confidence based on Australian Soil Classification criteria is given. Class 1-highly confident of soil attribute values given, analytic data available. Class 2-reasonably confident of values given, analytical data incomplete. Class 3-partial confidence in soil attribute values, no analytical data. Class 4-provisional confidence only, little experience of soil attributes provided |

### 2.3.5 Task 5 - Remote Sensing Interpretation

Where soil landscape mapping was non-existent and new soil landscape mapping had to be undertaken, the interpretation of 1:25 000 scale colour aerial photographs, 1:100 000 scale Landsat TM imagery, lithology and geological information was undertaken to enable provisional soil landscape boundaries to be identified and placed onto 1:100 000 topographic field sheets. Soil landscape strings for each soil landscape were also recorded. Radiometric and magnetic data were supplied nearing the end of the project with images corresponding fairly well with soil landscapes identified by soil survey. Unfortunately, due to time and budget constraints, additional field work could not be undertaken to check any anomalies.

### 2.3.6 Task 6 - Field assessment of soils

Provisional soil landscape boundaries were checked in the field and soil landscape point information recorded on specially designed CRA observation soil data cards (see Appendix 1) and entered into SALIS. These CRA cards were designed especially to meet the requirements of this project and included information on substrate fracturing, effective soil rooting depth, and convergent and divergent drainage attributes, which are useful for vegetation modelling. Many other casual observations were also made and recorded on field sheets and in notebooks. Table 2h shows the field attributes recorded at each site on CRA observation cards.

Mapping was conducted at a technical standard consistent with national agreements and standards developed under the Australian Collaborative Land Evaluation Program (ACLEP) by DLWC's Soil Survey Unit team of trained and qualified soil surveyors. Soil and land descriptions follow the guidelines of the *Soil and Land Survey Field Handbook* (Macdonald *et al.* 1990). Soil and land data collection used a combination of integrated and free soil survey and is a synthesis of methods outlined in the *Australian Soil and Land Survey Handbook-Guidelines to Conducting Surveys* (Gunn *et al.* 1988)

**TABLE 2H: CRA SITE ATTRIBUTES RECORDED**

| Parameter field | Soil Attribute |
|---|---|
| Landform | site and slope morphology<br>landform element<br>convergent/divergent slope<br>run-on contributing area |
| Topography | slope gradient<br>aspect |
| Lithology | solum parent material |

| | |
|---|---|
| | substrate<br>degree of fracturing<br>substrate strength<br>weathering and alteration<br>rock outcrop |
| Soil | A horizon<br>solum<br>depth to impeding layer<br>rooting depth<br>layer colour<br>layer soil texture<br>stone volume<br>layer soil structure<br>layer grade of structure<br>layer fabric<br>erosion hazard<br>ground cover<br>surface condition<br>Australian Soil Classification<br>Great Soil Group Classification |
| Vegetation | community<br>growth forms<br>upper stratum height |
| Hydrology | profile drainage/waterlogging<br>mottling<br>depth to watertable<br>runon/runoff<br>permeability |

### 2.3.7 Task 7- Collation of soil attribute information, scanning of maps and linking coverage to dataset

Following field work, soil surveyors on adjacent sheets discussed units mapped and ensured soil landscapes transgressed map sheet boundaries and were edge-matched on adjacent sheets. CRA soil profile cards were checked by soil surveyors and sent to SALIS for scanning into the system and later used to calculate EPAWC.

The 1:100 000 scale field sheets were traced onto a stable base and sent to the Soils Quality Officer at Parramatta for verification of soil landscape units with the central database and edge matching of polygons with adjacent sheets. Soil landscape details including the calculation of soil attributes (except EPAWC) were entered by the soil surveyors into the Access database for each map sheet. These were emailed or sent by disc to the Soils Quality Officer who arranged for the calculation of EPAWC and entry into the main database and verification by the Soils Quality Officer.

Soil landscape map tracings were checked for edge matching of soil landscape unit polygons and to ensure each had an entry in the database. Soil landscape tracings and the database were sent to NPWS for scanning within the timeframe required by NPWS. Discrepancies on the scanned maps and with the database were identified and corrected by the DLWC’s Soils Quality Officer with the assistance of soil surveyors where required.

In June 1999, a meeting attended by the Soils Quality Officer, NPWS Southern CRA coordinator and staff provided background on the Access database, which allowed NPWS to select required soil landscape attributes for linking to the coverage by the NPWS contractor. The linked datasets were then sent to BRS in Canberra for modelling and potential linking with digital elevation models to enhance the resolution of the soil attributes.

### 2.3.8 Task 8 - Linking of Acid Sulfate Soil (ASS) Coverage to the dataset

Following a request by NPWS to integrate the 1:25 000 ASS risk map coverage with the soil landscape coverage for the coastal sheets, DLWC employed a contractor to link these coverages together. Numerous ASS risk map codes were amalgamated into new soil landscape unit descriptions by the Soils Quality Officer (see Table 2I) and entered into a new Access database. This new ASS coverage and new ASS database was sent to the NPWS contractor who linked them and is now available for assisting in the modelling process. This acid sulfate soil landscape coverage was kept as a separate coverage to the Southern CRA.

**TABLE 2I: SOIL LANDSCAPE CODES CREATED FROM THE AMALGAMATION OF ACID SULFATE SOIL (ASS) CODES**

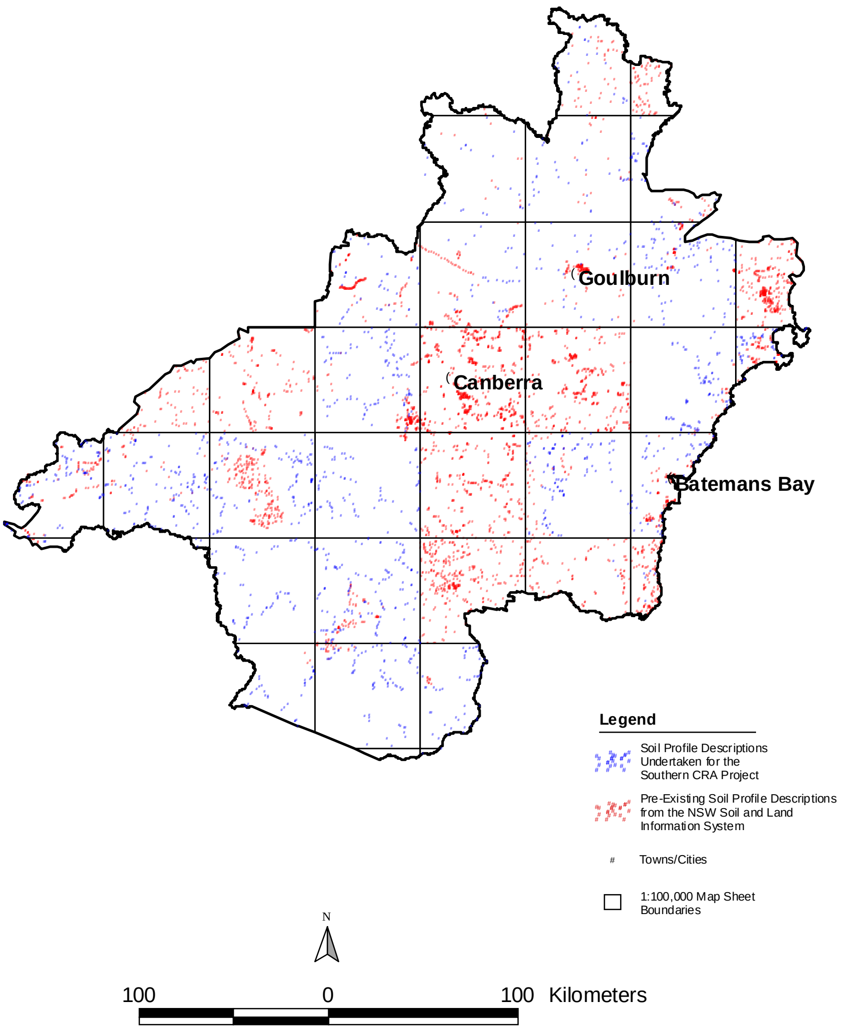
| Soil Landscape code | Description | Amalgamated DLWC ASS risk Code |
|---|---|---|
| **Water** | Bottom sediments in rivers and estuaries | N, H or L with Em, Am, Lm |
| ***Asa*** | Mangrove, saltmarsh areas and very low backswamps | N, H or L - Eu0, Ei0, Eu1, Ei1, Ek0, Ep0, Ec0, Er0, Eb0, En0, EsO, Ea0 |
| ***asb*** | *Casuarina glauca* low lying flats (Supratidal) | N, H or L - Ap1, Ep1, 1Lp, Ab1, Eb1, Er1, Ar1, Ec1, En1, Es1, Ak1, Ek1, El1, Ea1 |
| ***asc*** | Alluvial Swamps | all N, H and L - As2, As4, Ak2, Ak4 |
| ***asd*** | Sand dune swamps | N, H or L Wa1, Wd1 and Ws1, Ws2, Ws4 |
| ***asg*** | Low lying dunes and sandsheets; 2 - 4 m elevation; imperfectly drained | N, H or L with Wa 2, Wd2 |
| ***ase*** | Well-drained sandsheets and dunes | N, H or L with Wa4, Wd4 |
| ***asf*** | Beach and foredune deposits | B |
| ***xxz*** | Disturbed terrain extensively modified by human activity | any code with xx |
| ***ash*** | 2 - 4 m levee banks better drained than surrounding plain, often with tall forest | N, H or L Al2 |
| ***ask*** | 2 - 4 m alluvial plain; imperfectly drained | N, H or L Ap2, Ab2 |
| **zzz** | Coastal headland rock platforms formed by areas outside of SCRA and ASS mapping but inside NPWS 1:25 000 coastline. | NIL |

# 3. OUTPUTS

## 3.1 SOIL PROFILE INFORMATION

One-thousand-two-hundred-ninety-six (1296) CRA profiles were described as part of new soil landscape mapping of the Southern CRA Region. Figure 3A shows the distribution of soil profile sites for both newly mapped areas and existing soil landscape coverage. The data is held in SALIS, DLWC Parramatta.

**FIGURE 3A: SOIL PROFILE DATA POINTS WITHIN SOUTHERN CRA REGION**

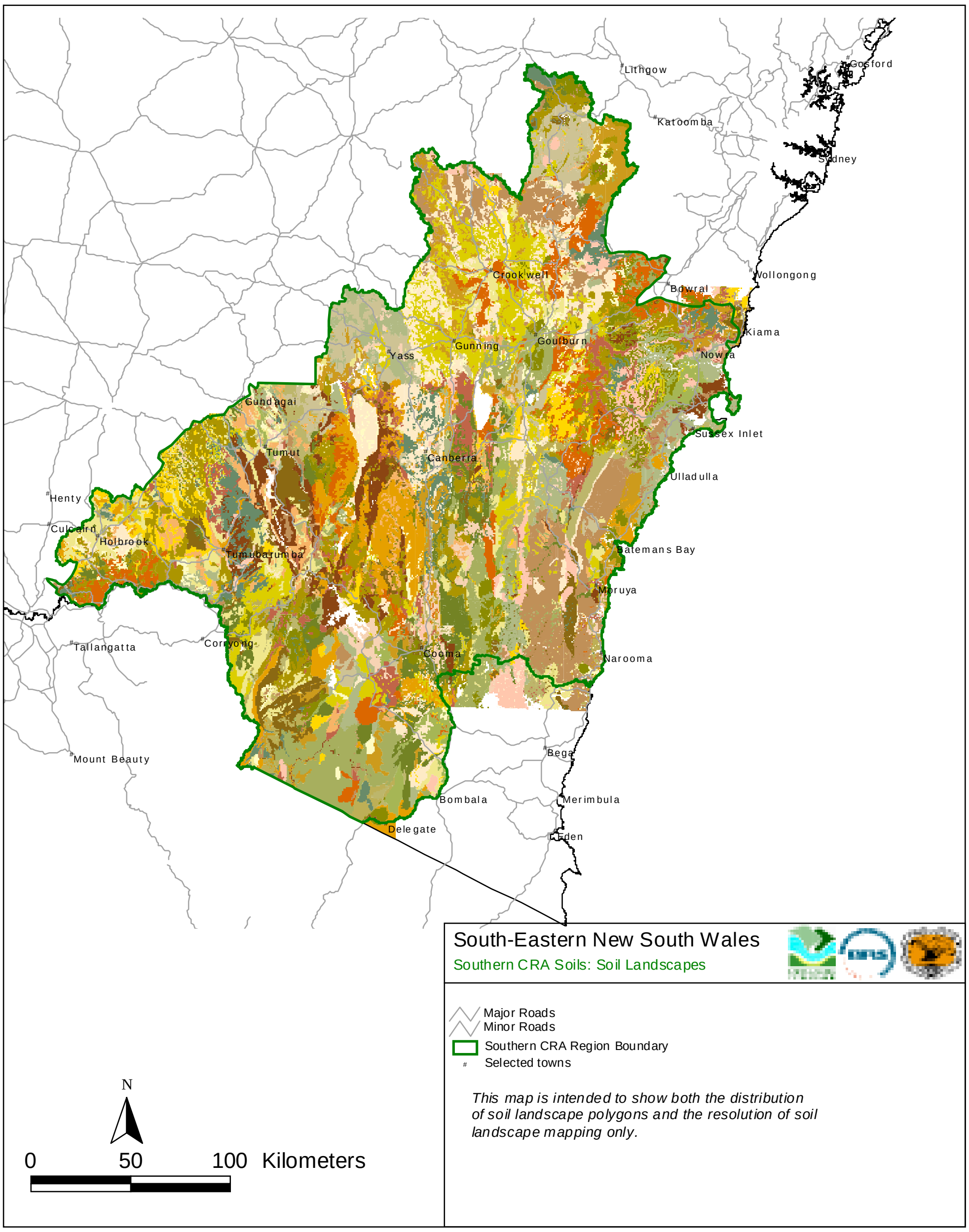


## 3.2 MAP COVERAGES AND DATABASE

### 3.2.1 Soil Landscape Coverage

A seamless, edge-matched coverage of soil landscapes for the entire Southern CRA region was completed (Map 3A). A total of 768 soil landscapes have been compiled from existing draft and published soil landscapes and from the undertaking of reconnaissance level 1:100 000 scale soil landscape mapping for this project. Furthermore, 1461 soil sub-landscapes with soil attribute data were created, which can be linked with digital elevation models to produce enhanced 1:25 000 coverage if required. This coverage and the matching database were sent to NPWS for modelling purposes.

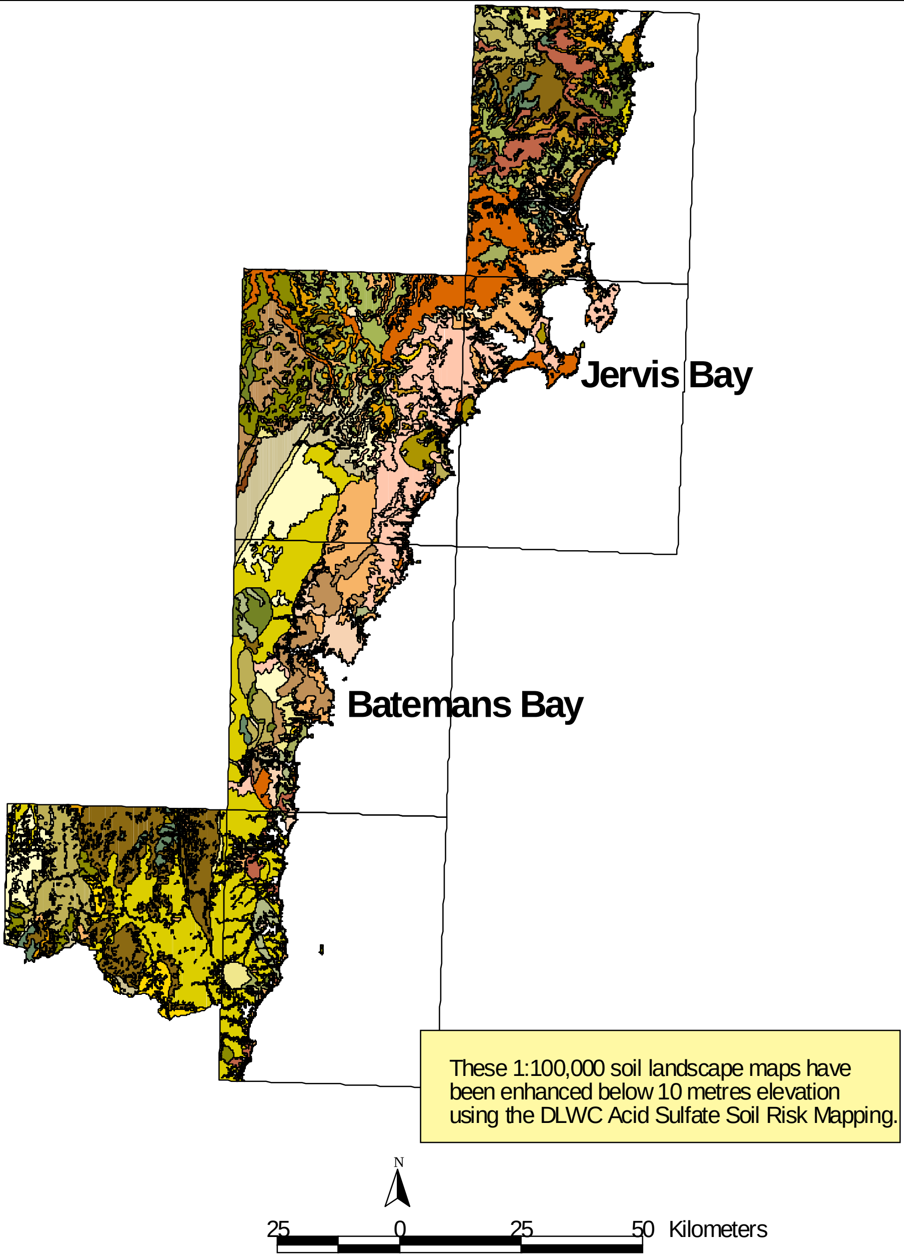
**MAP 3A: SOUTHERN CRA SOIL LANDSCAPE COVERAGE**



### 3.2.2 Acid Sulfate- Soil Landscapes Coverage

On request from the NPWS, a seamless acid sulfate/soil landscape coverage of the coastal sheets (Map 3b) was also compiled to provide further resolution of soil attributes in low lying terrain below 10 m AHD. This map was compiled by amalgamating DLWC Acid Sulfate Soil Risk map codes together to produce new soil landscapes that have similar soil attribute properties. This coverage and corresponding database were sent to NPWS for modelling purposes.

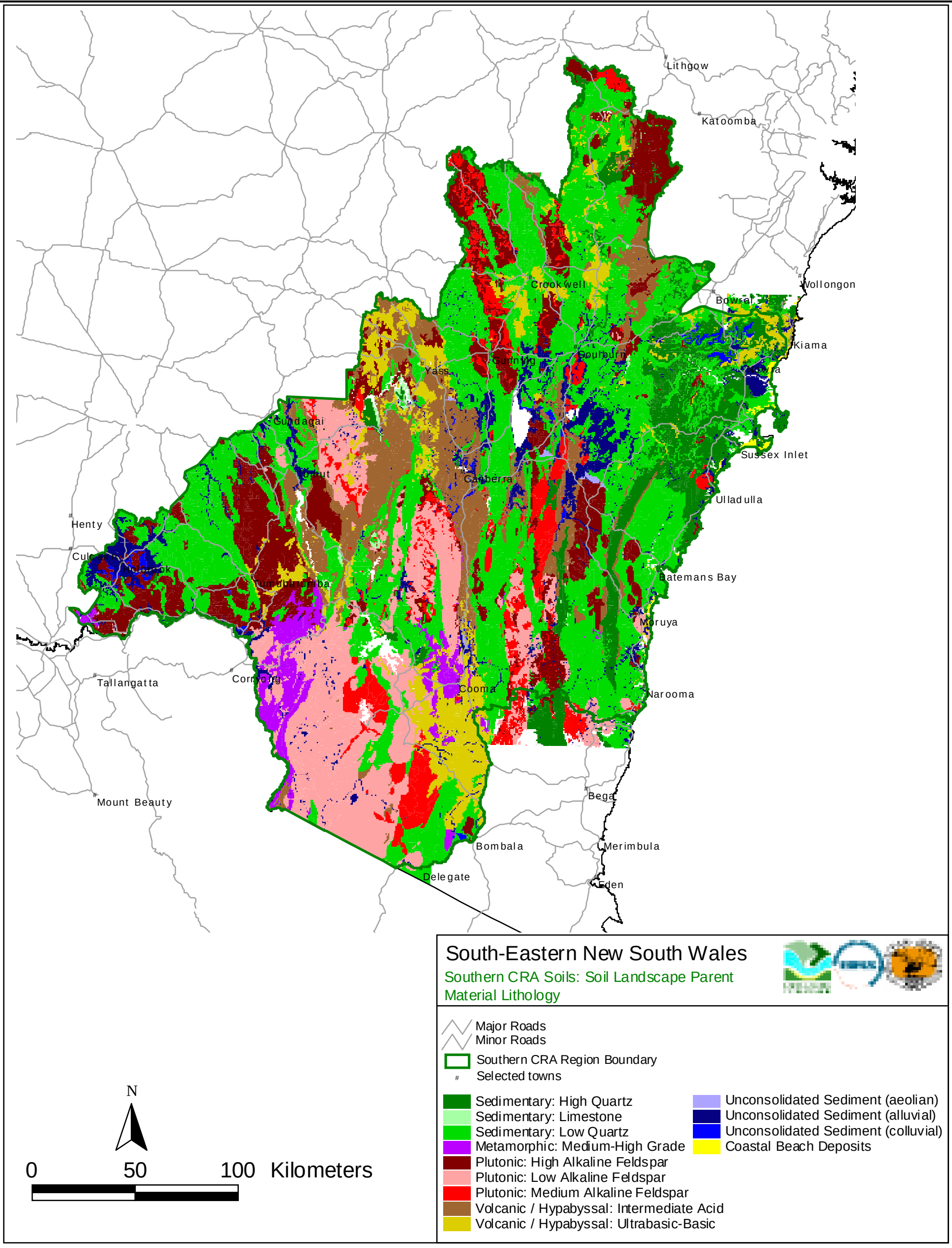
**MAP 3B: SOUTHERN CRA ACID SULFATE SOIL-SOIL LANDSCAPE COVERAGE**



### 3.2.3 Soil Landscape-Parent Material Lithology coverage

A 1:100 000 scale Parent Material and Lithology map was also compiled using the soil landscape mapping coverage (Map 3C) and lithology attribute information recorded for each soil landscape. Based on CSIRO lithology groupings supplied by NPWS, this new lithology coverage provides more accurate information at a higher resolution (1:100 000 scale). Furthermore, the CSIRO lithology group "unconsolidated sediments" was sub-divided into *alluvium*, *aeolian* and *colluvium* lithology groups to assist with vegetation modelling. This is a major improvement on the previous 1:250 000 lithology.

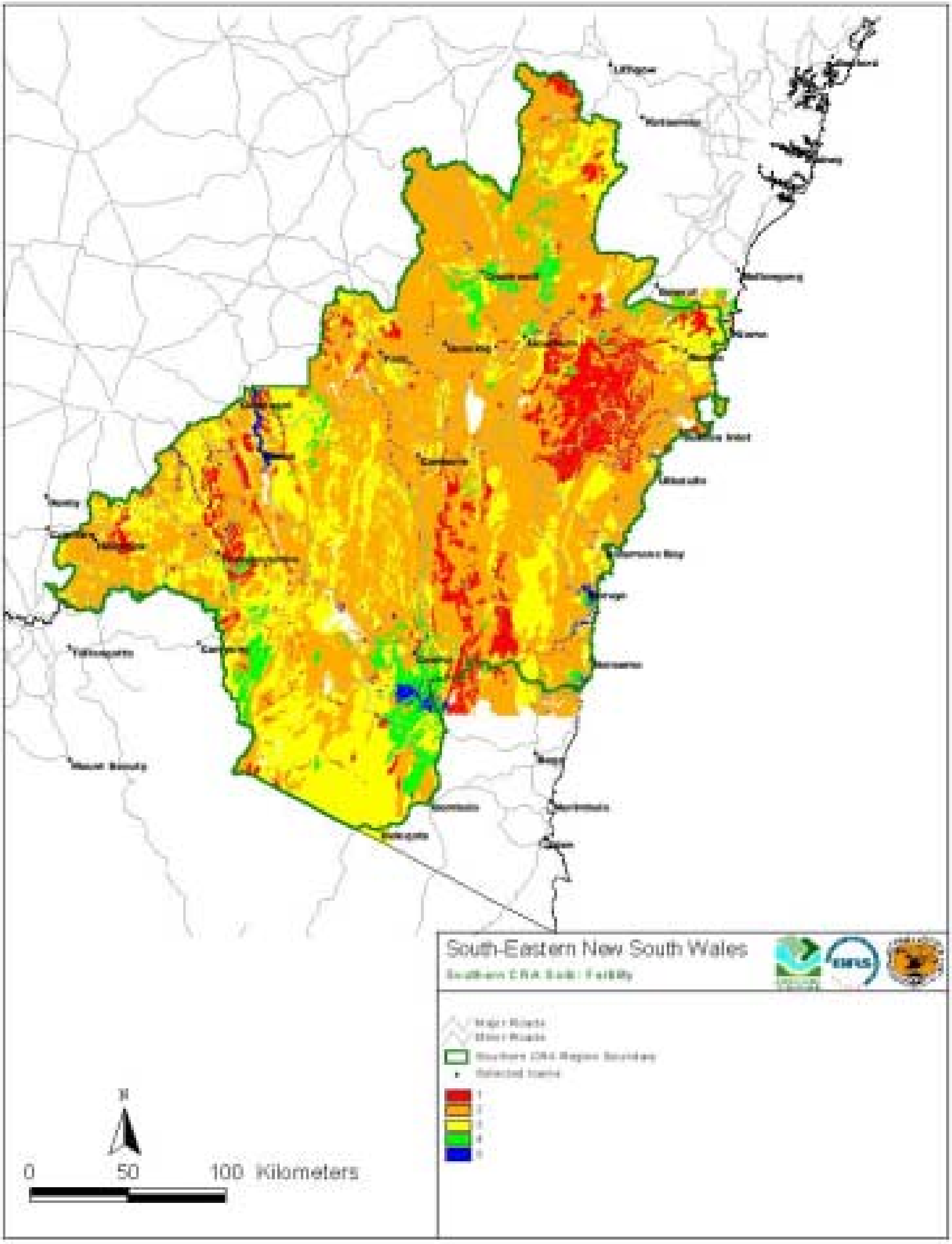
**MAP 3C: PARENT MATERIAL LITHOLOGY COVERAGE**



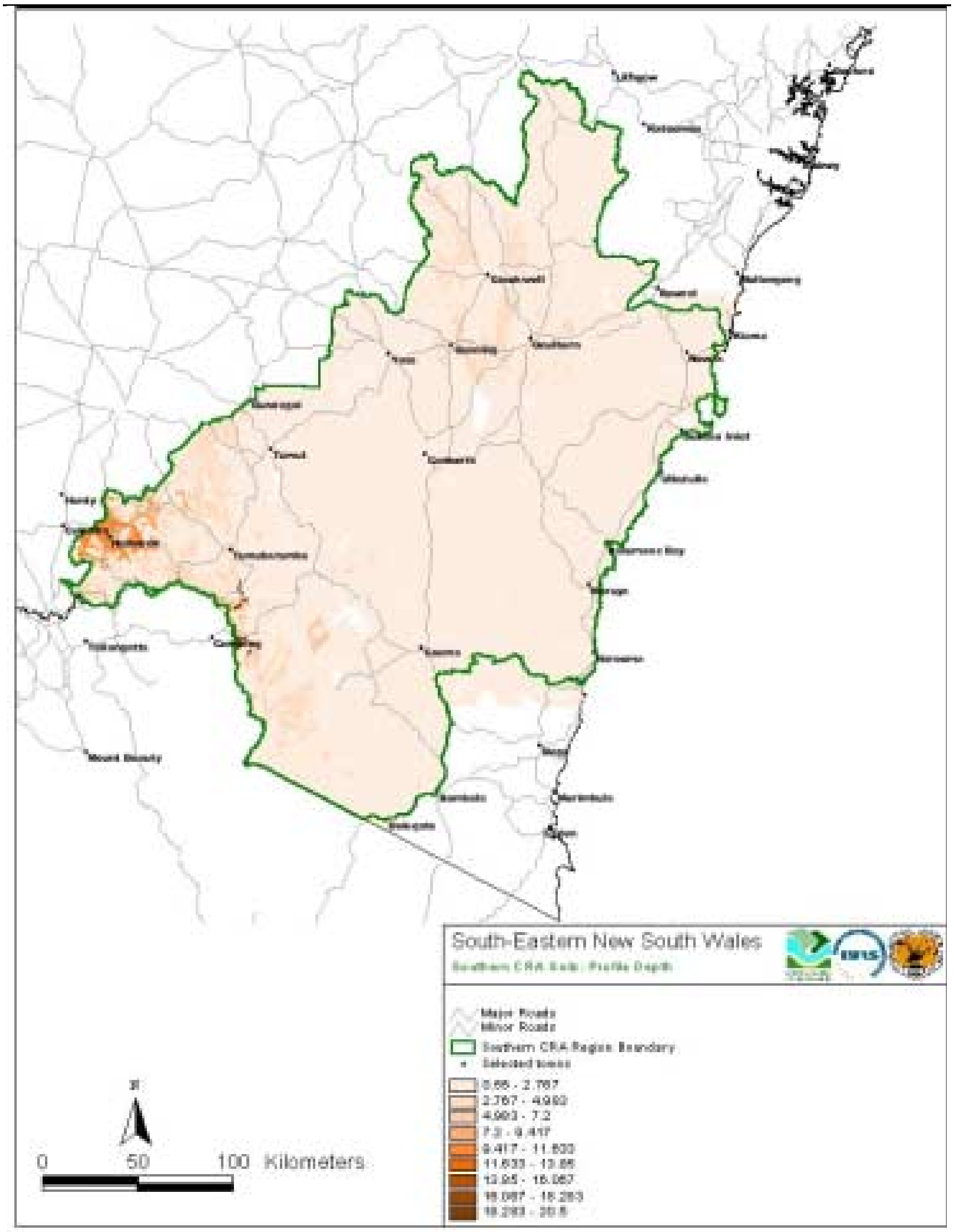
### 3.2.4 Soil Attribute Themes

Examples of current soil attribute themes for Fertility (Map 3D), Soil Profile Depth (Map 3E), Effective Rooting Depth (Map 3G) and Estimated Plant Available Water-holding Capacity (Map 3H) were generated by BRS. These themes were compiled from the soil landscape coverage (Map 3A) and information in the Access database, and are displayed as weighted averages for soil sub-landscape values. They are likely to be revised as the modelling process evolves.

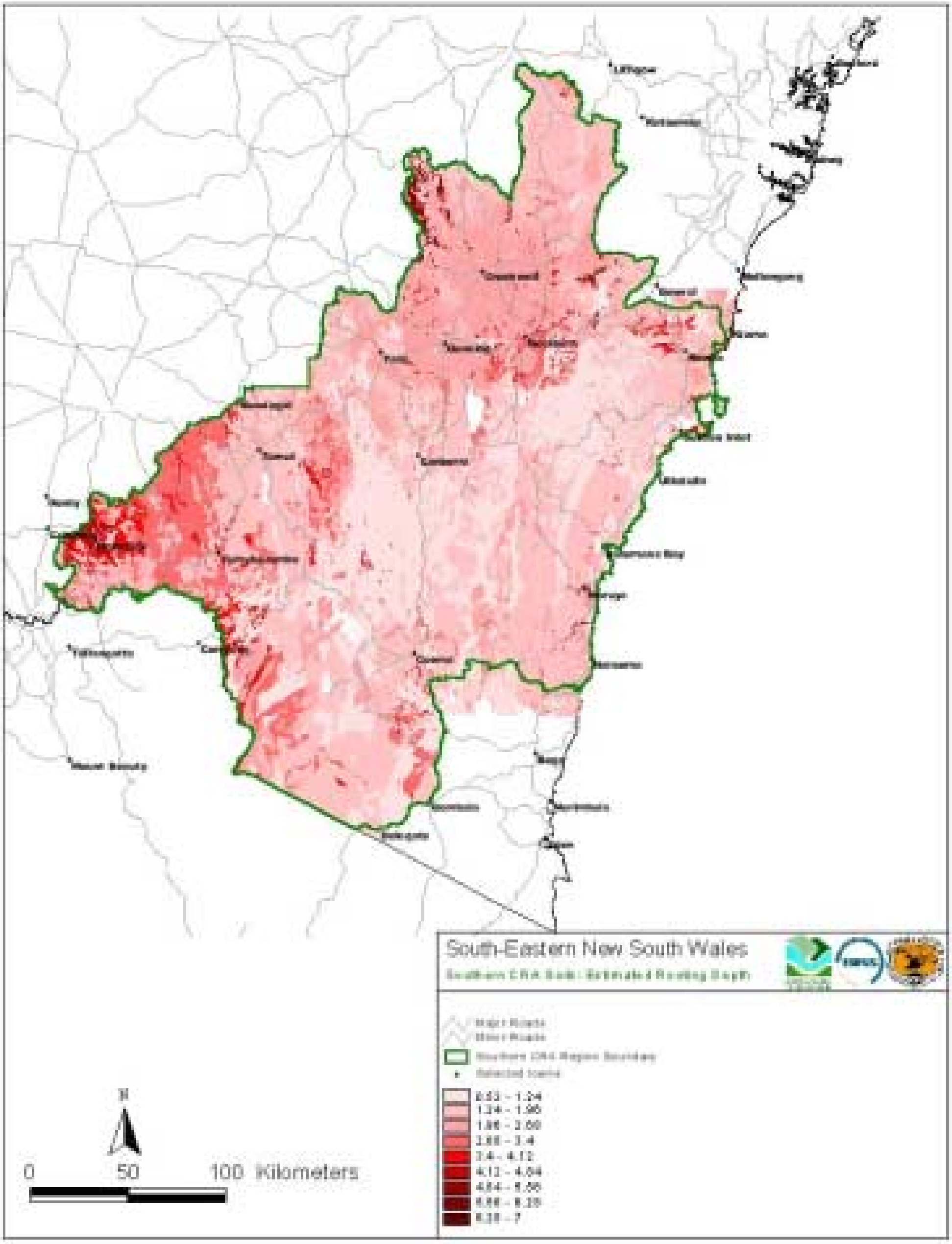
**MAP 3D: SOIL FERTILITY**



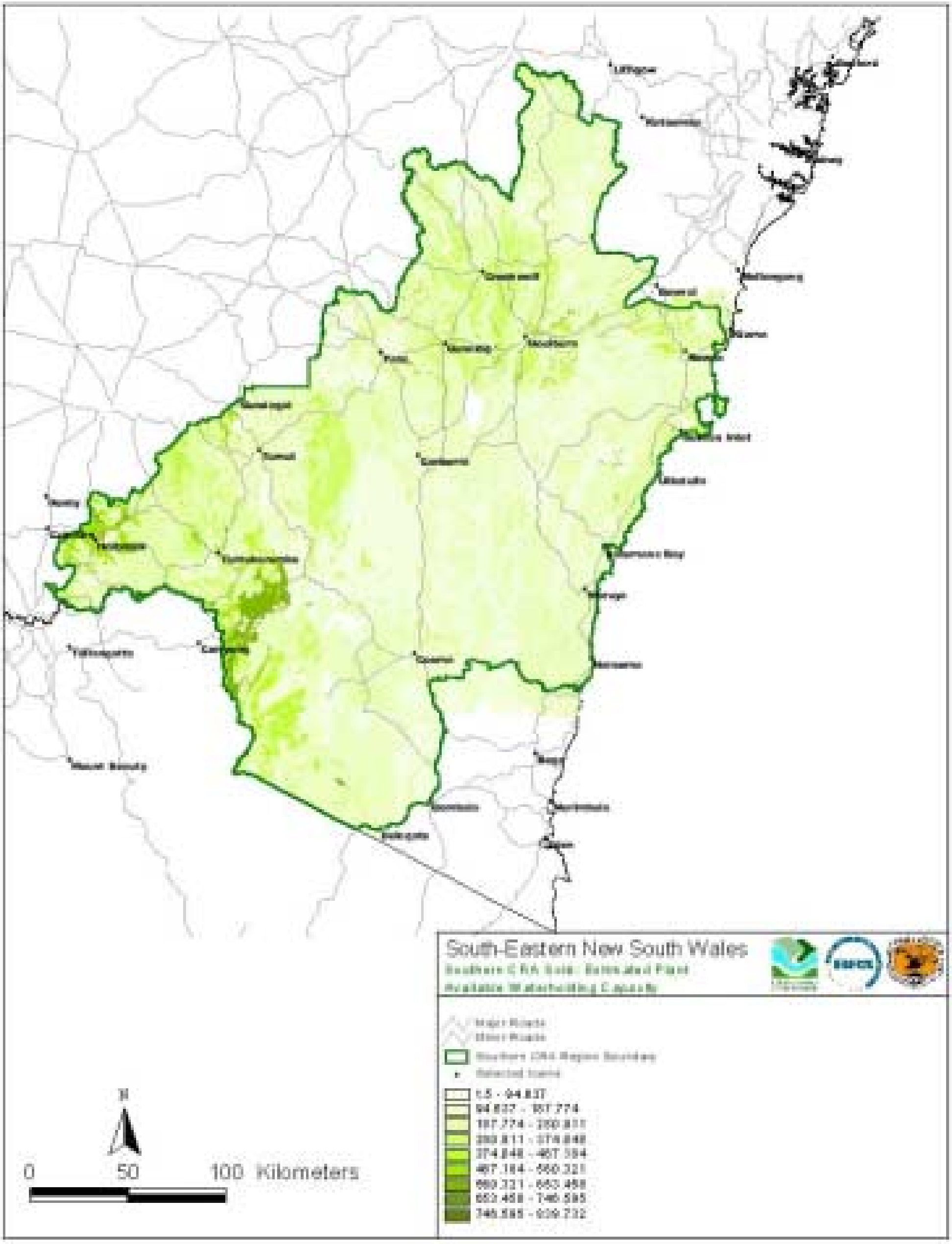
## MAP 3E: SOIL PROFILE DEPTH



## MAP 3F: EFFECTIVE ROOTING DEPTH



## MAP 3G: ESTIMATED PLANT AVAILABLE WATER-HOLDING CAPACITY



### 3.2.5 Soil Landscape Database

An Access database was produced that contains detailed soil landscape descriptions for each soil landscape in the SCRA project. It includes information on the main soil attributes useful for vegetation modelling (e.g., fertility, EPAWC, ERD and drainage). An enhanced 1: 25 000 digital coverage of these soil attributes can be made by linking soil sub-landscape attributes contained within each soil landscape with digital terrain models such as CTI. Additionally, other soil and landscape information was collated (e.g., soil type, soil and landscape limitations) for each soil landscape, which makes it useful for a multitude of purposes other than vegetation modelling.

## 3.3 USE OF DATA

These maps and the associated database provide a guide to the distribution and assessment of soil landscape attributes across Southern CRA region. They were undertaken at a reconnaissance level over a short time period and should be used for only broad regional vegetation modelling purposes only.

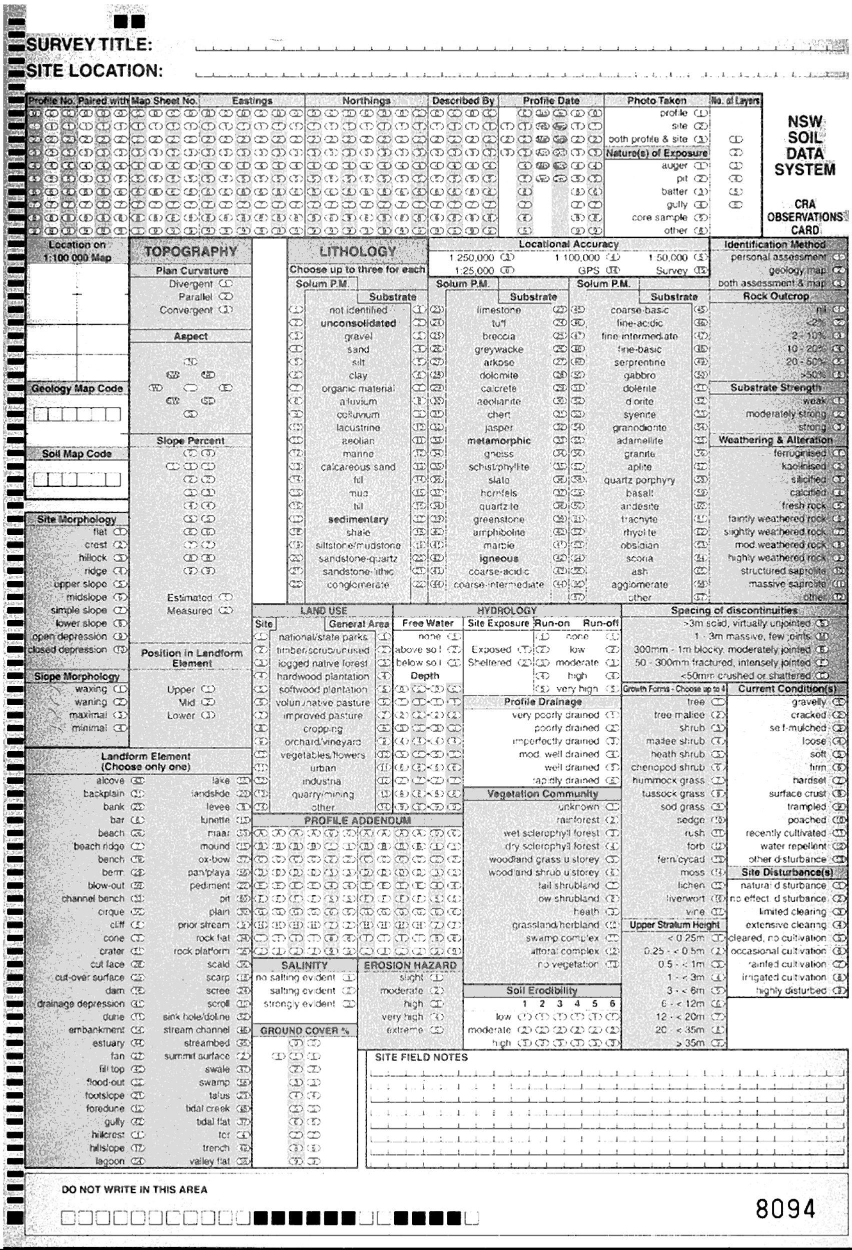
The maps should be used only at 1:100 000 scale or smaller and should not be used for any purposes other than those specified in this project without the written permission of DLWC.

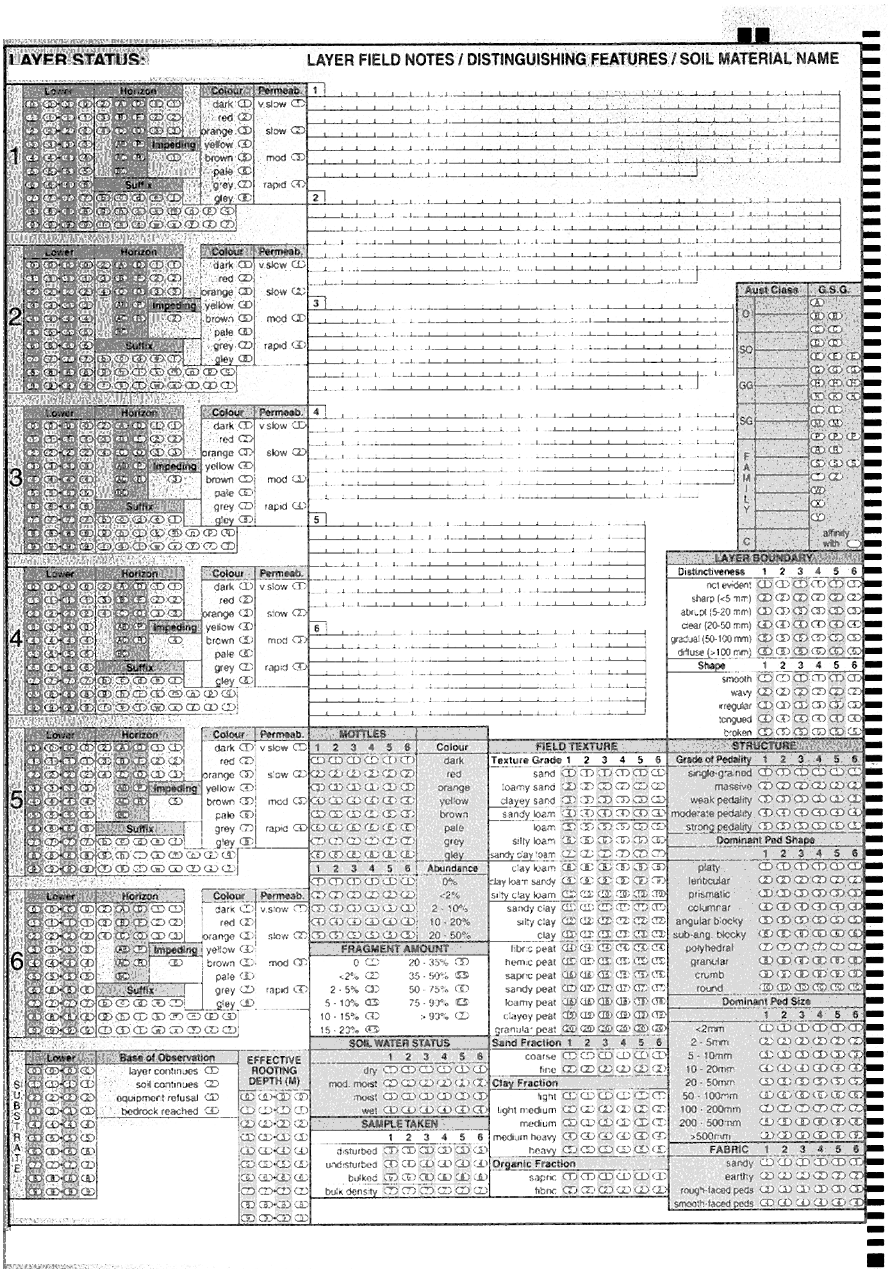
Enhanced resolution of these soil attributes can be gained through linkage with digital elevation models. This will be undertaken by BRS as required for modelling purposes. The soil attribute themes generated will assist in the modelling of:

- biodiversity assessment
- pre-1750s and current forest community modelling
- fauna modelling
- rare flora species modelling
- centres of endemism
- response to disturbance
- plantation potential on cleared private land, and
- industry development opportunities (e.g., intensification).

# APPENDIX 1

## EXAMPLE OF CRA SOIL PROFILE OBSERVATION CARD


SURVEY TITLE:
SITE LOCATION:
Profile No. Paired with Map Sheet No. Eastings Northings Described By Profile Date Photo Taken No. of Layers
profile site both profile & site
Nature(s) of Exposure
auger pit batter gully core sample other
NSW SOIL DATA SYSTEM
CRA OBSERVATIONS CARD
Location on 1:100 000 Map
TOPOGRAPHY
Plan Curvature
Divergent Parallel Convergent
Aspect
Geology Map Code
Soil Map Code
Slope Percent
Estimated Measured
Site Morphology
flat crest hillock ridge upper slope midslope simple slope lower slope open depression closed depression
Position in Landform Element
Upper Mid Lower
Slope Morphology
waxing waning maximal minimal
Landform Element (Choose only one)
alcove backplain bank bar beach beach ridge bench berm blow-out channel bench cirque cliff cone crater cut face cut-over surface dam drainage depression dune embankment estuary fan fill top flood-out footslope foredune gully hillcrest hillslope lagoon
lake landslide levee lunette maar mound ox-bow pan/playa pediment pit plain prior stream rock flat rock platform scald scarp scree scroll sink hole/doline stream channel streambed summit surface swale swamp talus tidal creek tidal flat tor trench valley flat
LITHOLOGY
Choose up to three for each
Solum P.M. Substrate
not identified unconsolidated gravel sand silt clay organic material alluvium colluvium lacustrine aeolian marine calcareous sand fill mud till sedimentary shale siltstone/mudstone sandstone-quartz sandstone-lithic conglomerate
limestone tuff breccia greywacke arkose dolomite calcrete aeolianite chert jasper metamorphic gneiss schist/phyllite slate hornfels quartzite greenstone amphibolite marble igneous coarse-acidic coarse-intermediate
coarse-basic fine-acidic fine-intermediate fine-basic serpentine gabbro dolerite diorite syenite granodiorite adamellite granite aplite quartz porphyry basalt andesite trachyte rhyolite obsidian scoria ash agglomerate other
Locational Accuracy
1:250,000 1:100,000 1:50,000 1:25,000 GPS Survey
Identification Method
personal assessment geology map both assessment & map
Rock Outcrop
nil <2% 2 - 10% 10 - 20% 20 - 50% >50%
Substrate Strength
weak moderately strong strong
Weathering & Alteration
ferruginised kaolinised silicified calcified fresh rock faintly weathered rock slightly weathered rock mod weathered rock highly weathered rock structured saprolite massive saprolite other
LAND USE
Site General Area
national/state parks timber/scrub/unused logged native forest hardwood plantation softwood plantation volun./native pasture improved pasture cropping orchard/vineyard vegetables/flowers urban industrial quarry/mining other
HYDROLOGY
Free Water
none above soil below soil
Depth
Site Exposure
Exposed Sheltered
Run-on Run-off
none low moderate high very high
Spacing of discontinuities
>3m solid, virtually unjointed
1 - 3m massive, few joints
300mm - 1m blocky, moderately jointed
50 - 300mm fractured, intensely jointed
<50mm crushed or shattered
Profile Drainage
very poorly drained poorly drained imperfectly drained mod. well drained well drained rapidly drained
Growth Forms - Choose up to 4
tree tree mallee shrub mallee shrub heath shrub chenopod shrub hummock grass tussock grass sod grass sedge rush forb fern/cycad moss lichen liverwort vine
Current Condition(s)
gravelly cracked self-mulched loose soft firm hardset surface crust trampled poached recently cultivated water repellent other disturbance
Vegetation Community
unknown rainforest wet sclerophyll forest dry sclerophyll forest woodland grass u storey woodland shrub u storey tall shrubland low shrubland heath grassland/herbland swamp complex littoral complex no vegetation
Site Disturbance(s)
natural disturbance no effect disturbance limited clearing extensive clearing cleared, no cultivation occasional cultivation rainfed cultivation irrigated cultivation highly disturbed
Upper Stratum Height
< 0.25m 0.25 - < 0.5m 0.5 - < 1m 1 - < 3m 3 - < 6m 6 - < 12m 12 - < 20m 20 - < 35m > 35m
PROFILE ADDENDUM
SALINITY
no salting evident salting evident strongly evident
EROSION HAZARD
slight moderate high very high extreme
Soil Erodibility
1 2 3 4 5 6
low moderate high
GROUND COVER %
SITE FIELD NOTES
DO NOT WRITE IN THIS AREA
8094



LAYER STATUS:

LAYER FIELD NOTES / DISTINGUISHING FEATURES / SOIL MATERIAL NAME

Layers 1–6: Lower | Horizon | Impeding | Suffix | Colour: dark, red, orange, yellow, brown, pale, grey, gley | Permeab.: v.slow, slow, mod, rapid

Aust Class | G.S.G.

O, SO, GG, SG, FAMILY, C

affinity with

LAYER BOUNDARY

Distinctiveness 1 2 3 4 5 6: not evident, sharp (<5 mm), abrupt (5-20 mm), clear (20-50 mm), gradual (50-100 mm), diffuse (>100 mm)

Shape 1 2 3 4 5 6: smooth, wavy, irregular, tongued, broken

MOTTLES 1 2 3 4 5 6

Colour: dark, red, orange, yellow, brown, pale, grey, gley

Abundance: 0%, <2%, 2 - 10%, 10 - 20%, 20 - 50%

FRAGMENT AMOUNT: 0, <2%, 2 - 5%, 5 - 10%, 10 - 15%, 15 - 20%, 20 - 35%, 35 - 50%, 50 - 75%, 75 - 90%, > 90%

FIELD TEXTURE

Texture Grade 1 2 3 4 5 6: sand, loamy sand, clayey sand, sandy loam, loam, silty loam, sandy clay loam, clay loam, clay loam sandy, silty clay loam, sandy clay, silty clay, clay, fibric peat, hemic peat, sapric peat, sandy peat, loamy peat, clayey peat, granular peat

Sand Fraction 1 2 3 4 5 6: coarse, fine

Clay Fraction: light, light medium, medium, medium heavy, heavy

Organic Fraction: sapric, fibric

STRUCTURE

Grade of Pedality 1 2 3 4 5 6: single-grained, massive, weak pedality, moderate pedality, strong pedality

Dominant Ped Shape 1 2 3 4 5 6: platy, lenticular, prismatic, columnar, angular blocky, sub-ang. blocky, polyhedral, granular, crumb, round

Dominant Ped Size 1 2 3 4 5 6: <2mm, 2 - 5mm, 5 - 10mm, 10 - 20mm, 20 - 50mm, 50 - 100mm, 100 - 200mm, 200 - 500mm, >500mm

FABRIC 1 2 3 4 5 6: sandy, earthy, rough-faced peds, smooth-faced peds

SUBSTRATE: Lower | Base of Observation: layer continues, soil continues, equipment refusal, bedrock reached

EFFECTIVE ROOTING DEPTH (M)

SOIL WATER STATUS 1 2 3 4 5 6: dry, mod. moist, moist, wet

SAMPLE TAKEN 1 2 3 4 5 6: disturbed, undisturbed, bulked, bulk density

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