LAND USE MAPPING OF THE NORTHERN TERRITORY

TECHNICAL REPORT 02/2003D

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CONTENTS

LIST OF FIGURES

LIST OF TABLES

1. INTRODUCTION

1.1 Background

The Northern Territory's landscapes are by and large intact. Whilst land use and management practices have created problems in some areas, the potential to realise sustainable resource development remains largely undiminished. Land use data, used in conjunction with existing land capability, climate and other data, can provide predictive capacity to assist in assessing the likely impacts of current and proposed policy affecting land use and land management.

Accurate and reliable land use data is an important input into effective natural resource planning and management. At the time of this project digital land use data was available from the Northern Territory Valuer-General's Office, however, this was mainly confined to the urban centres and based upon the Australian and New Zealand Land Use Classification (ANZLUC). Land use data across the rest of the Northern Territory is quite limited and generally not in a digital format, but this was more than compensated for by local knowledge. By collating data from disparate datasets and expert knowledge, this project has been able to develop the first Territory-wide land use dataset based upon the Australian Land Use and Management (ALUM) Classification (version 5). The outputs from this project are already being utilised in the assessment of current and future ground water usage in the peri-urban/intensive agriculture areas around Darwin and Palmerston.

1.2 Objectives

The objective of this project was the production of a land use dataset for the whole of the Northern Territory to nationally agreed ALUM specifications. Specifically the project outputs comprise:

- Land use data in digital Arc/Info format and map form at scales suitable for a variety of client groups;
- metadata in accordance with Australia New Zealand Land Information Council (ANZLIC) Guidelines, including results of the validation process; and
- a report on the methods used, problems encountered and opportunities for improving the mapping process.

Priority areas for the Northern Territory, as can be seen in Figure 1, were identified as

Pastoral Zone	Low Intensity land use mapping (1:250,000 mapping)	Low priority
Northern Agricultural Zone	Medium intensity mapping (1:100,000 mapping)	**High priority**
Peri-Urban Intensive Agricultural Zones	High intensity mapping (1:25,000 mapping)	**High priority**

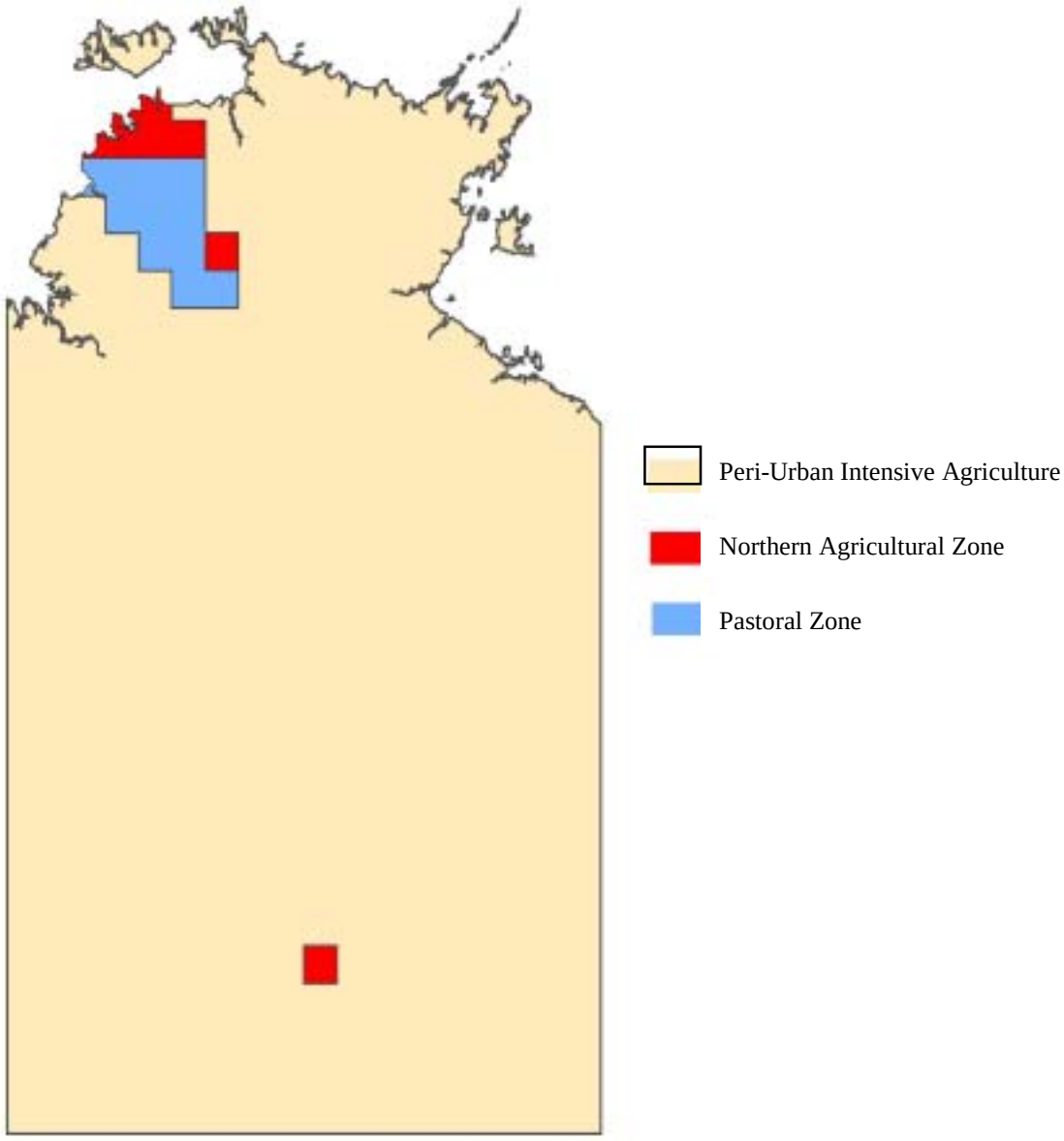

Figure 1 Mapping Zones of the Northern Territory

2. METHOD

2.1 Overview

The mapping procedure involved successive stages of data collation, interpretation (including the production of draft land use maps), verification (involving field checking and editing), independent validation and the production of final outputs (land use data, metadata and validation results). These procedures are detailed in the technical handbook prepared to support land use mapping in Australia – *Land Use Mapping at Catchment Scale: Principles, Procedures and Definitions, Edition 2* (Bureau of Rural Sciences, 2002).

The technical handbook is also the primary reference for the land use classification scheme used in this project – The Australian Land Use and Management (ALUM) Classification (version 5) which is presented in full in Appendix 1.

The ALUM Classification has a three-tiered hierarchical structure with five primary levels of land use distinguished in order of generally increasing levels of intervention or potential impact on the natural landscape. Water is also included in the classification as a sixth primary class because of its importance for natural resources management and the significance of water features as points of reference in the landscape:

1. Conservation and natural environments - Land used primarily for conservation purposes, based on the maintenance of the essentially natural ecosystems present.
2. Production from relatively natural environments - Land used primarily for primary production based on limited change to the native vegetation.
3. Production from dryland agriculture and plantations - Land used mainly for primary production, based on dryland farming systems.
4. Production from irrigated agriculture and plantations - Land used mostly for primary production based on irrigated farming.
5. Intensive uses - Land subject to extensive modification, generally in association with closer residential settlement, commercial or industrial uses.
6. Water - Water features. Water is regarded as an essential aspect of the classification, but it is primarily a cover type.

The principles that underpin the ALUM Classification / Baxter-Russell (1994) approach include:

Level of intervention - The classification is based on identification and delineation of types and levels of intervention in the landscape, rather than descriptions of land use based on outputs.
Generality - The classification is designed to provide for users who are interested in both processes (eg land management practices) and outputs (eg commodities).
Hierarchical structure - The hierarchical structure provides for and promotes aggregation/disaggregation of related land uses, the addition of levels or classes and relevance at a range of scales.
Prime use / Ancillary use – Parcels of land may be subject to a number of concurrent land uses. A multiple use production forest, for example, has as its main management objective the production of timber, although it also may also provide conservation, recreation, grazing and water catchment services. Land use class allocations based on prime use are based on the primary land management objective of the nominated land manager.

In mapping the Northern Territory, the minimum level of attribution was the Secondary level (see Appendix 1) and generally, mapping was completed to the Tertiary level only where pre-existing data was available. The attribution of multiple uses in separate database fields, using ALUM Classification, occurred only where such information was likely to be of particular relevance to local/regional planning and/or management.

2.2 Data collation and preparation

Existing datasets containing information relating to land use were collated and assessed. Key data sources for this project were the Northern Territory Digital Cadastre, Northern Territory Valuer-General data, ortho-rectified aerial photograph mosaics, Australian Greenhouse Office Year 2000 Mosaic satellite imagery, other remotely sensed Landsat ETM and TM data, and AUSLIG GEODATA TOPO-250k® Series 1 and 2. The project team ortho-rectified all aerial photographs for the project using the Northern Territory Digital Cadastre and a Digital Elevation Model (DEM) in ER Mapper® 6.2. These photographs were mosaiced and compressed as an ECW (Enhanced Compressed Wavelet) file in ER Mapper® 6.3. All datasets were compiled in Arc/Info® compatible format. The datasets utilised are included in Appendix 6.

The Northern Territory Digital Cadastre was selected as the most appropriate base map for the project and a copy was obtained in Arc/Info® format. Roads and coastal rivers are not polygons in the Northern Territory Digital Cadastre and were closed off by the project team. For the purposes of this project the Northern Territory was divided into three zones, the Urban & Peri-urban Intensive Agriculture Zone, Northern Agricultural Zone of the Katherine-Daly region and the Pastoral Zone which includes much of the land owned and managed by Aboriginal communities (refer Figure 1).

After being split along longitude 132^0east and reprojected into the GDA94 MGA Zones 52 and 53 coordinate systems, the base map was clipped into ten Arc/Info® coverages, each to be mapped separately. Six MGA Zone 52 coverages encompass the Urban & Peri-urban Intensive Agriculture Zone around Darwin. Each of these coverages were based on the Auslig 1:100,000 series topographic maps of Darwin (5073), Koolpinyah (5173), Mary River (5272), Fog Bay (4972), Bynoe (5072), Noonamah (5172). The two coverages for the Northern Agricultural Zone, one each in MGA94 Zone 52 and Zone 53, included all or part of the following Auslig 1:250,000 scale topographic map sheets – Pine Creek (SD52-08), Cape Scott (SD52-07), Fergusson River (SD52-12) and Katherine (SD53-09). The Pastoral Zone comprised the rest of Northern Territory divided into MGA94 Zones 52 and 53. The Urban & Peri-urban Intensive Agricultural Zones encompassing parts of the Katherine (5369), Manbulloo (5368) and Alice Springs (5659) topographic map sheets were not clipped from the larger covers.

2.3 Interpretation

This stage involved interpreting land use from source datasets, creating the base land use coverage and preparing draft land use maps for verification and field checking. Land use codes were assigned according to the ALUM Classification (version 5) (see Appendix 1). Steps included:

- The interpretation of data into appropriate land use classes and the creation of the base land use coverage based upon the polygons of the Northern Territory Digital Cadastre with coded land use attributes. Vector data was managed in Arc/Info® coverage format.
- Entering interpreted data details into a metadata table;
- Checking the interpreted classes against remotely sensed data;
- Merging some digital datasets to create features and assigning land use codes;
- Checking the topology (Arc/Info cleaning and building) of draft land use dataset; and
- Sanity checking attributes with respect to land use class code and description.

2.4 Verification and editing

Verification of draft land use maps includes the annotation of field maps on the basis of expert advice and field checking, and the editing of land use polygons. Territory agencies and personnel familiar with local patterns of land use made an important contribution to this process. Steps in the verification and editing process included:

- Creating draft maps – 1) land use with cadastral boundaries and 2) remotely sensed data with cadastral boundaries;
- Meeting regional officers, annotating land use maps, and revising field plans on the basis of the information acquired;

- Conducting field checks where practicable. The Northern Territory project made maximum use of real time land use mapping by using a vehicle mounted laptop/GPS with draft land use maps and other digital data loaded for comparison and navigation;
- Attributing polygons with appropriate codes and annotating for editing; and
- Editing, checking and building topology.

2.5 Independent Validation

The validation procedure compared attribute information in the land use dataset with information obtained from independent field survey and is designed to give data users a general indication of attribute accuracy. Validation was carried out shortly after the completion of mapping and involved personnel who had not participated in mapping. The number of sample points used in validation limits the statistical confidence that can be placed in measures of accuracy for those land use classes of small areal extent. The error matrix for the Northern Territory project is included in the metadata (Appendix 3). As with final whole of Northern Territory dataset, the attribute accuracy for each individual mapping area needs to be greater than 80% to meet specifications. If a map failed to achieve greater that 80% attribute accuracy the area was re-mapped and the validation procedure repeated.

The validation procedure involved:

- A minimum of 50 sample sites established for each of the ten mapping areas.
- Sample sites allocated to each land use class that can be checked in the field. The Technical Manual stipulates that these are proportional to the area of each land use class and not less than 2% of the mapping area. As the data was to be used for a variety of purposes it was decided that land use classes with not less than 0.5% of the mapping area were to be included in the validation process. Even so, only 44 of the 86 land use classes mapped for the Northern Territory were validated.
- The random selection of sample sites within each identified land use class. Land use classes that could not readily be tested/validated by field observation were excluded.
- Construction of an error matrix and accuracy assessment that compared mapped land use classes at sample sites with independently observed land use classes for each mapping area. The error matrix for final Northern Territory dataset is included as Appendix 4.
- Mapping areas that failed to achieve greater that 80% attribute accuracy were re-mapped and the validation procedure repeated

2.6 Outputs

This stage included the finalisation of the land use dataset, final report including metadata, validation reporting and quality assurance. The metadata for land use datasets is included in Appendix 3. The quality assurance checklist for the project area was completed by the Bureau of Rural Sciences and is included as Appendix 5.

3. RESULTS

The completed Northern Territory land use map is shown in Figure 2. The mapped area covers 1.3million km^2 extending to all Northern Territory borders. No interstate cadastral information was available to enable a buffer to be created. As can be seen in Table 1, land use in the Northern Territory is dominated by two Land Use Classes, 'Grazing natural vegetation' with an areal extent of 45.45% of the land area and Aboriginal land managed for 'Traditional indigenous uses' occupies a further 43.15%. Land managed as 'Remnant native cover' accounts for around 5.77%, National Parks and other conservation areas account for 3.38%, and 'Defence' 0.92%. All other forms of primary production, from dryland agriculture and grazing to irrigated horticulture, account for less than 0.5% of the Territory's land area.

Of the remaining 1.33% land area, residential areas comprised of 'Urban residential', 'Rural residential' and 'NT rural', and cover 557 km^2 or 0.04% of the Northern Territory. 'Rural residential'

cover 332 km^2 and 'NT rural' cover 166 km^2 whilst 'Urban residential' covers only 58 km^2. Roads and railways together cover over 2100 km^2 or about 0.16%.

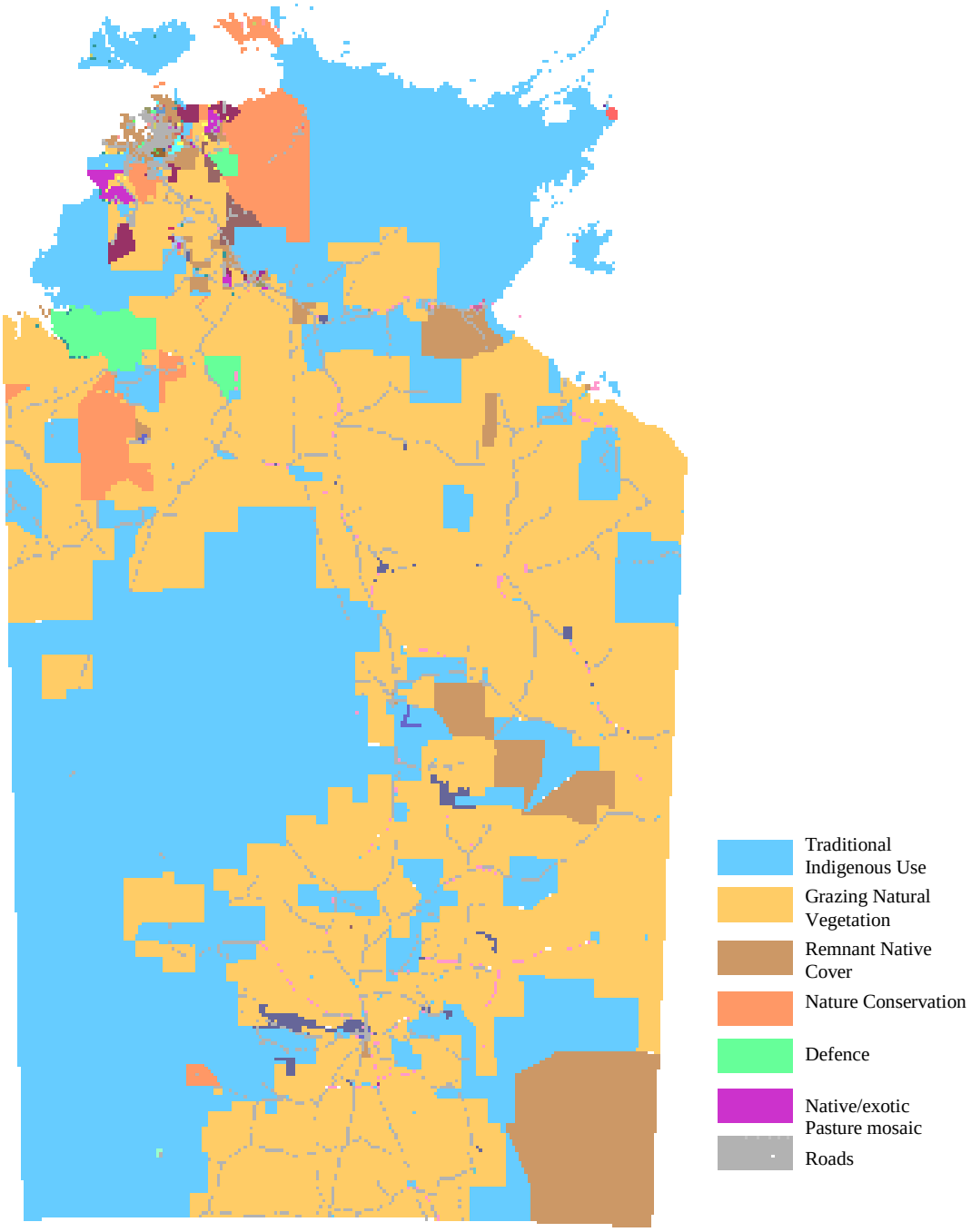

Figure 2 Land Use Map of the Northern Territory

Table 1 Primary land use by tertiary class, area and percentage of the Northern Territory

LU_Code_1	Description	Km^2	Percentage
1.1.0	Nature conservation	5155.2	0.38%
1.1.3	National park	37614.2	2.79%
1.1.4	Natural feature protection	2.9	0.00%
1.1.5	Habitat/species management area	2725.0	0.20%
1.1.6	Protected landscape	1.7	0.00%
1.1.7	Other conserved area	188.1	0.01%
1.2.2	Surface water supply	250.5	0.02%
1.2.4	Landscape	14.9	0.00%
1.2.5	Traditional indigenous uses	581534.6	43.15%
1.3.0	Other minimal use	4395.3	0.33%
1.3.1	Defence	12372.6	0.92%
1.3.2	Stock route	0.0	0.00%
1.3.3	Remnant native cover	77734.5	5.77%
1.3.4	Rehabilitation	261.4	0.02%
1.3.5	NT rural	165.9	0.01%
2.1.0	Grazing natural vegetation	612463.0	45.45%
2.2.0	Production forestry	0.2	0.00%
3.1.2	Softwood production	3.6	0.00%
3.2.0	Grazing modified pastures	3178.5	0.24%
3.2.1	Native/exotic pasture mosaic	1846.5	0.14%
3.2.4	Legume/grass mixtures	0.0	0.00%
3.2.5	Sown grasses	5.1	0.00%
3.3.0	Cropping	198.3	0.01%
3.3.1	Cereals	0.5	0.00%
3.3.3	Hay & silage	9.1	0.00%
3.4.0	Perennial horticulture	0.1	0.00%
3.5.0	Seasonal horticulture	1.0	0.00%
4.2.4	Irrigated sown grasses	2.1	0.00%
4.3.0	Irrigated cropping	22.6	0.00%
4.3.1	Irrigated cereals	37.0	0.00%
4.4.0	Irrigated perennial horticulture	9.1	0.00%
4.4.1	Irrigated tree fruits	91.1	0.01%
4.4.4	Irrigated vine fruits	34.5	0.00%
4.4.8	Cleared	12.8	0.00%
4.5.0	Irrigated seasonal horticulture	8.1	0.00%
4.5.1	Irrigated fruits	3.1	0.00%
4.5.4	Irrigated vegetables & herbs	0.2	0.00%
5.1.0	Intensive horticulture	2.5	0.00%
5.1.1	Shadehouses	0.5	0.00%
5.2.1	Dairy	3.1	0.00%
5.2.2	Cattle	3.9	0.00%
5.2.4	Poultry	0.6	0.00%
5.2.5	Pigs	0.1	0.00%
5.2.6	Aquaculture	135.9	0.01%
5.3.0	Manufacturing and industrial	31.9	0.00%
5.4.0	Residential	0.7	0.00%
5.4.1	Urban residential	58.0	0.00%
5.4.2	Rural residential	243.1	0.02%
5.5.0	Services	0.8	0.00%

LU_Code_1	Description	Km^2	Percentage
5.5.1	Commercial services	133.7	0.01%
5.5.2	Public services	516.6	0.04%
5.5.3	Recreation and culture	157.9	0.01%
5.5.4	Defence facilities	164.1	0.01%
5.5.5	Research facilities	47.2	0.00%
5.6.0	Utilities	14.7	0.00%
5.6.1	Electricity generation/transmission	0.5	0.00%
5.6.2	Gas treatment, storage & trans	0.1	0.00%
5.7.0	Transport and communication	0.0	0.00%
5.7.1	Airports/aerodromes	20.4	0.00%
5.7.2	Roads	1847.0	0.14%
5.7.3	Railways	255.3	0.02%
5.7.4	Ports and water transport	6.0	0.00%
5.7.5	Navigation and communication	13.9	0.00%
5.8.0	Mining	5.4	0.00%
5.8.1	Mines	94.1	0.01%
5.8.2	Quarries	17.8	0.00%
5.9.1	Stormwater	0.0	0.00%
5.9.3	Solid garbage	1.6	0.00%
6.0.0	Water	0.0	0.00%
6.1.0	Lake	74.2	0.01%
6.1.1	Lake - conservation	2.8	0.00%
6.1.2	Lake - production	6.5	0.00%
6.2.0	Reservoir/dam	42.5	0.00%
6.2.1	Water storage and treatment	1.4	0.00%
6.2.2	Reservoir - intensive use	5.0	0.00%
6.2.4	Effluent pond	0.9	0.00%
6.3.0	River	496.7	0.04%
6.3.1	River - conservation	18.0	0.00%
6.4.0	Channel/aqueduct	0.0	0.00%
6.4.1	Supply channel - water pipe	0.4	0.00%
6.4.2	Drainage channel/aqueduct	0.0	0.00%
6.5.0	Marsh/wetland	306.2	0.02%
6.5.1	Marsh/wetland - conservation	111.6	0.01%
6.5.2	Marsh/wetland - production	19.8	0.00%
6.6.0	Estuary/coastal waters	42.1	0.00%
6.6.3	Estuary/coastal waters - intensive	136.0	0.01%

4. DISCUSSION

4.1 General

Source datasets and other source information were prioritised according to accuracy and reliability (See Table 2 below). Land use information was entered using land use data that was obtained from fieldwork, image interpretation, local knowledge and other ancillary digital datasets.

Table 2 Source dataset priority

Priority of information	Order of use
1. Local knowledge	1. Cadastre
2. Field work	2. Aerial photography
3. Aerial photography	3. Northern Territory Valuer General
4. Cadastre	4. AGO Year 2000 Australia Mosaic
5. Northern Territory Valuer General	5. Field work
6 AGO Year 2000 Australia Mosaic	6. Local knowledge
7. Land Cover themes 1995 (ALCC)	7. Land Cover themes 1995 (ALCC)

The latest available scanned digital aerial photographs were obtained for the Peri-urban Intensive Agricultural Zone. These were ortho-rectified using the cadastre and a Digital Elevation Model, mosaiced and compressed in ER Mapper® 6.2. Ortho-rectification Root Mean Square (RMS) errors were less than 5m.

Mosaiced ortho-rectified aerial photography, the Northern Territory Digital Cadastre and Northern Territory Valuer-General data were used to interpret land use in the Urban and Peri-urban Intensive Agriculture Zone. Where practical up to three land uses were attributed for each cadastral polygon in this zone (see section 4.2 below). However, the Northern Territory Valuer-General data available at the time of this project was not up-to-date in parts of the rural area. Four Peri-urban Intensive Agriculture Zone coverages failed first round validation with attribute accuracy not exceeding the required 80%. As no secondary digital dataset was available, the failed land use codes were remapped in the field using a copy of the coverage (as a MapInfo® 6.5 .tab file) on a laptop linked to a vehicle mounted GPS via GeoTracker®. In this manner more than 1500 land parcels were remapped.

Roads and railways were attributed using land tenure and ownership information with the cadastre. Roads and coastal rivers are not polygons in the Northern Territory Digital Cadastre and were closed off by the project team. Conservation areas were attributed using land tenure and ownership information with the cadastre. Water bodies were attributed from the Auslig Geodata Topo-250k® Series 1& 2 that was combined with the Peri-urban Intensive Agriculture Zone and Northern Agricultural Zone mapping. Urban areas were mapped from the cadastre and Northern Territory Valuer General data. Indigenous land use was attributed from land tenure and ownership. Grazing was attributed using land tenure and ownership information with the cadastre, imagery and local knowledge.

For the verification, remapping and validation phases of the project, draft maps were assessed by personnel with local knowledge of the Katherine, Darwin and Alice Springs regions who had not been involved in the original mapping. On completion of verification stage, the individually mapped coverages were merged in Arc/Info® 8.2 and the complete dataset reprojected from GDA94 MGA Zones 52 and 53 to the GDA94 geographical coordinate system.

All attribution was undertaken in accordance with the ALUM Classification (Version 5), however two additional classes were added to satisfy the conditions within the Northern Territory. These were Land Use Class 1.3.5 ‘NT rural’ for rural living on blocks predominantly covered by remnant native cover with no agricultural development, and Land Use Class 4.4.8 ‘Cleared’ for areas cleared in preparation for horticultural development.

4.2 Prime Use

Class allocation was generally made on the basis of the primary management objective of the land manager. This means, for example, developed residential areas within reserved areas (such as within Kakadu and Uluru-Kata Tjuta National Parks) were classed as 5.4.1 'Urban residential', the prime use being urban/residential, rather than nature conservation.

The Northern Territory Land Use dataset includes multiple land use attributes for cadastral land parcels in the Peri-urban Intensive Agriculture and Northern Agricultural Zones where such information was likely to be of particular relevance to local/regional planning and/or management. The Northern Territory dataset also contains a number of additional fields not accounted for in the project Technical Manual (Bureau of Rural Sciences, 2002). Within these zones, multiple land use was mapped as a primary land use (Lu_Code) and up to two other significant land uses (Luc_2 and Luc_3). Each land use was attributed using the ALUM Classification (version 5) and had the estimated areal proportion (less than or equal to 1) it occupied in the land parcel assigned. The sum of the land use proportions must equal one for each land parcel. The area for each land use is calculated from the proportional value.

For example, a 20 hectare rural block with a house and sheds, a 4 hectare irrigated orchard and the rest remnant native vegetation would be mapped as follows: Primary land use is 'Rural residential' (proportion 0.1); the multiple land uses being 'Irrigated tree fruits' (proportion 0.2) and 'Remnant native cover' (proportion 0.7). For the purposes of the project, 5 hectare was deemed to be the minimum area of perennial or seasonal horticulture to be considered commercially the most significant land use in the Peri-urban Intensive Agriculture Zone. In the above example, if the orchard was 5 hectare or greater 'Irrigated tree fruits' would be classified as the primary land use and 'Rural residential' as a multiple use.

4.3 Temporal Change

Some land uses are relatively stable, remaining in place over decades or more. In other cases, land use turnover is extremely rapid - this particularly applies where land use change is geared to seasonal or annual cycles, for example pasture/crop rotations. Where rapid turnover occurs, the temporal mis-match between source data and field verification poses difficulties. The agreed principle applied to land use mapping was to assign land use classes at the time of data capture (the date of the relevant input data sources - primarily imagery, cadastre and field attribution). This means, in the case of crop/pasture rotations for example, that the assigned land use will be either a modified pasture class (3.2) or a cropping class (3.3). Change in land use from 'Remnant native cover' to 'NT rural' to 'Rural residential' is a typical progression that is inherent in the Peri-urban Intensive Agriculture Zone particularly around Darwin.

4.4 Data Resolution and Accuracy

In this project, as the existing polygons of the Northern Territory Digital Cadastre were used as the project base map, the minimum data resolution standard (or minimum mapping unit) for land use mapping stipulated in the Technical Manual (Bureau of Rural Sciences,2002) was adopted. Data resolution standards vary according to the significance of features being mapped and the source from which land use information is drawn. Intensive land use features that are readily discriminated will, for instance, be mapped with higher resolution than extensive, low intensity land uses. Information relating to data resolution is detailed in the metadata.

Spatial precision or positional accuracy refers to the variation among individual measurements of geographic coordinates from a spatial reference. The spatial precision of final outputs is affected by the spatial precision of source information and data processing methods. Spatial accuracy was tested by comparing the positions of known locations within land use datasets with corresponding positions as determined by surveys of a higher accuracy. The spatial accuracy of project datasets varied, whilst the cadastre was within 7m of surveyed ground points; generally accuracy ranged from 5-50m with respect to the cadastre, the variation largely relating to data sources.

Thematic or attribute accuracy is a measure of success (usually expressed as a percentage) in assigning polygons of a thematic map to their correct categories. The required attribute accuracy of greater than 80% was achieved in all mapped areas (range from 80.3 to 100%) with the final merged dataset accuracy 81.8%. Measured accuracy for particular land uses varied, such as in the Peri-urban Intensive Agriculture Zone where discriminating 1.3.3 'Remnant native cover', 1.3.5 'NT rural' or 5.4.2 'Rural residential' was difficult using remotely sensed data due to the rate of change in this zone. The same can be said for 4.4.0 'Irrigated perennial horticulture' and its precursor 4.4.8 'Cleared'.

4.5 Class Allocation Issues

The key Land Use Class allocation issues encountered during this project are discussed below. Two additional Land Use Classes were defined, 1.3.5 'NT rural' and 4.4.8 'Cleared', to more accurately represent land uses in the Northern Territory.

1.3.0 Other Minimal Use

Where there was no applicable prime land use, or land use and land cover were indeterminate, the land parcel was allocated to this class. If the land use was indeterminate, but land cover could be established through existing data or local knowledge then, if appropriate, the parcel was allocated to 1.3.3 'Remnant native cover'.

1.3.3 Remnant native cover

All land uses involving conservation or production from relatively natural environments retain native cover to a greater or lesser extent. The 'Remnant native cover' class was usually used where land cover could be established and there was no applicable prime use, or where land use was indeterminate. Livestock, for instance, occasionally graze 'Remnant native cover' but where grazing takes place on a regular or semi-regular basis and this is the intended prime use for the land then 2.1.0 'Grazing natural vegetation' is the appropriate class. Generally, woody vegetation cover on private land (identified from the ALCC Land Cover Themes 1995 and other sources) and not assigned to a higher level use was assigned to 2.1.0 'Grazing natural vegetation' (see section following). 'Remnant native cover' may be an appropriate class allocation for some of these areas however, there was insufficient information available at the time of mapping to systematically re-assign areas to this class.

1.3.5 NT rural

The 'NT rural' class was established to allow appropriate allocation of land use, mainly in the Peri-urban Intensive Agriculture Zone, for residential developments on land that retains much native cover. This class consists of 'rural' land parcels on which development/clearing is limited to house, sheds and firebreaks with no discernible agricultural activity. This is often the transitional class from 1.3.3 'Remnant native cover' to 5.4.2 'Rural residential' once agricultural activity commences.

2.1.0 Grazing natural vegetation

Difficulties were commonly encountered in distinguishing livestock grazing on relatively natural environments from grazing on modified pastures (where an exotic or native pasture component has been deliberately introduced or actively promoted - eg through fertilising). In the project area livestock grazing occurs on a range of pasture types including native, modified and mixtures of both. Difficulties meant that 2.1.0 'Grazing natural vegetation' was assigned by default to privately held land with a woody vegetation cover, and no higher level use unless field observation/expert knowledge confirmed another class, usually 3.2.0 'Grazing modified pastures'.

3.2.0 Grazing modified pastures

Floodplain pastures along the coast and within Northern Agricultural Zone can be a complex mix of native, exotic and mosaic pastures, combinations of which are amenable to a variety of pasture improvement practices. Generally, pastures on coastal floodplains have been modified to some degree (through deliberate introduction or active promotion of a pasture component). However, there was varying levels of information available to enable classification of 3.2.0 'Grazing modified pastures' at

the Tertiary level and thus only those areas for which field observation/expert knowledge confirmed another class were classed as 3.2.1 ‘Native/exotic pasture mix’.

4.4.8 Cleared

The ‘Cleared’ class was established to allow appropriate class allocation for cleared land, mainly in the Peri-urban Intensive Agriculture Zone, that, from airphoto analysis and/or field observation, was intended for horticultural development. For cleared land where there is no applicable prime use, or where land use is indeterminate, such land was allocated to 1.3.0 ‘Other minimal use’.

5.4.2 Rural residential

Where rural land is managed as a hobby farm, it was allocated as rural residential. The size of rural allotments and local government zoning plans were used as an indicator of rural residential land use.

Water and land use

Because water is considered a land cover for the purposes of this project, rather than a land use, water classes are not mutually exclusive with other land use classes at particular levels in the classification. Generally, water classes take precedence so that, for instance, a lake in a conservation reserve is classed as 6.1.1 ‘Lake’ rather than 1.1.0 ‘Nature conservation’.

4.6 Using Land Use Data Outputs

In general, the land use data outputs produced in this project are more suited for use at the catchment or regional scale. The attribution of multiple land uses, and their areal proportions, is intended to expand the options for the use of this dataset. However, the suitability of the data for particular purposes should be considered carefully against a range of factors concerning applicability of the classes used by the ALUM Classification (version 5), data resolution, spatial precision and attribute accuracy. In particular, users need to assure themselves that the accuracy and precision of the data match the phenomenon/issue being addressed. The minimum attribute accuracy target of greater than 80% applies to the dataset overall, however some individual classes failed to meet this standard, (See Error Matrix, Appendix 4). Other specifications set for land use mapping represent a balance between mapping accuracy, logistical and resource constraints (such as limited field time, availability and/or age of source data) and the utility of the data.

Certain aspects of mapping procedure may also be important in assessing the usefulness of land use outputs. For instance, the validation procedure, designed to give users an indication of the attribute accuracy of mapping, is not definitive for land uses of small areal extent because of the necessarily limited number of sampling sites across the study area. Eighty land use classes have been identified in this project, however the validation procedure assessed only forty-four of these.

Temporal change is also an issue affecting the suitability of the data for particular uses. Mapping identifies land use at a particular point in time, but land use change can occur over very short time periods, for example crop/pasture rotations. Particular caution should be exercised in interpreting land uses that have a seasonal sensitivity or propensity for rapid change. In the Northern Territory this is most apparent in the Peri-urban Intensive Agriculture Zone, where the transition from 1.3.3 'Remnant native cover' to 1.3.5 ‘NT rural’ then 5.4.2 ‘Rural residential’ during the life of the project was noted for numerous blocks (See Error Matrix, Appendix 4).

In hindsight, water bodies ought not to have been included in the primary dataset. As a separate layer these would be updated regularly when more Auslig Geodata 250K Series 2 becomes available. Land use classification would then be achieved through spatial merges as and when required, enabling the most up-to-date land use data and water body mapping to be utilised.

Project metadata and quality assurance statements are helpful in assessing the suitability of data for particular uses. Such documentation and the data itself can only retain value if both are updated regularly.

Analysis of land capability information in conjunction with land use mapping data will provide a rapid means of identifying land that may not be being used within its optimum capability. These areas can be targeted for advisory activities and could become the subject of special environmental management policies.
A number of issues remain to be resolved with respect to the custodianship and ongoing maintenance of this dataset. These include:

- Agreement for and then design and implementation of maintenance/update program;
- Possible instruments to facilitate updating land use data could include, but are not limited to:
  - ❖ Applications for development or vegetation clearing through the Department of Infrastructure, Planning and Environment.
  - ❖ Applications for development on pastoral lands.
  - ❖ Extension services offered through Northern Territory Government Agencies.
  - ❖ Water licence applications through the Department of Infrastructure, Planning and Environment.
- Data accessibility issues; and
- Dealing with potentially commercially sensitive information.

There are a number of potential uses for the data from this project. The geo-coded land use dataset will facilitate the following:

- Evaluation of patterns of existing or proposed land use in relation to current land zoning.
- A base-line description of the extent of native vegetation in clearing legislation.
- Modelling potential offsite pollution risks when used in combination with surface and groundwater data.
- Targeting extension programs by advisory staff.
- Rapid assessment of likely environmental impacts of proposed developments.

Analysis of land capability information in conjunction with land use mapping data will provide a rapid means of identifying land that may not be being used within its optimum capability. These areas can be targeted for advisory activities and could become the subject of special environmental management policies. Land use data is already being used to assess current and future ground water usage in the peri-urban/intensive agriculture areas around Darwin and Palmerston

5. CONCLUSIONS

This project has achieved the first Territory-wide land use dataset, produced to nationally agreed specifications, that will assist natural resources planning and management at the regional or catchment level. It represents the outcome of a partnership between the Commonwealth and other State and Territory bodies.

The land use data produced by this project represents a narrow ‘snap-shot’ in time, relying on data from 1997 to 2002. However, through the use of digital data and geospatial analysis methods, new information should be able to be incorporated into the existing mapping, allowing it to be regularly updated, particularly for areas undergoing substantial change. This can be achieved by incorporating changes detected via aerial photography and other newly available source information into the existing data sets. For instance, mapping of larger properties down to paddock level would enable refinement of Tertiary land use classes for grazing or assessment of the level of historical land clearing.

Regional communities and local governments are increasingly active in developing responses to natural resource management problems, assessing opportunities for agricultural diversification, and development. Demand for nationally consistent digital land use and land management practices mapping at the catchment level is likely to continue to increase. Land use data from this project has the potential to play a critical role in the management of natural resources and in assessing the effectiveness of investment by Government in Natural Resource Management programs. Together with climate, surface and ground water, land cover and soils, this information will be fundamental in helping Territory and Local governments, researchers and communities assess alternative courses of action in moving to the sustainable management of Northern Territory landscapes.

6. REFERENCES

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APPENDIX 1 AUSTRALIAN LAND USE AND MANAGEMENT CLASSIFICATION (V5)

AUSTRALIAN LAND USE AND MANAGEMENT CLASSIFICATION version 5 (November 2001)

1 Conservation and Natural Environments

1.1.0 Nature conservation
1.1.1 Strict nature reserves
1.1.2 Wilderness area
1.1.3 National park
1.1.4 Natural feature protection
1.1.5 Habitat/species management area
1.1.6 Protected landscape
1.1.7 Other conserved area

1.2.0 Managed resource protection
1.2.1 Biodiversity
1.2.2 Surface water supply
1.2.3 Groundwater
1.2.4 Landscape
1.2.5 Traditional indigenous uses

1.3.0 Other minimal use
1.3.1 Defence
1.3.2 Stock route
1.3.3 Remnant native cover
1.3.4 Rehabilitation

minimum level of attribution

2 Production from Relatively Natural Environments

2.1.0 Grazing natural vegetation

2.2.0 Production forestry
2.2.1 Wood production
2.2.2 Other forest production

3 Production from Dryland Agriculture & Plantations

3.1.0 Plantation forestry
3.1.1 Hardwood production
3.1.2 Softwood production
3.1.3 Other forest production
3.1.4 Environmental

3.2.0 Grazing modified pastures
3.2.1 Native/exotic pasture mosaic
3.2.2 Woody fodder plants
3.2.3 Pasture legumes
3.2.4 Pasture legume/grass mixtures
3.2.5 Sown grasses

3.3.0 Cropping
3.3.1 Cereals
3.3.2 Beverage & spice crops
3.3.3 Hay & silage
3.3.4 Oil seeds
3.3.5 Sugar
3.3.6 Cotton
3.3.7 Tobacco
3.3.8 Legumes

3.4.0 Perennial horticulture
3.4.1 Tree fruits
3.4.2 Oleaginous fruits
3.4.3 Tree nuts
3.4.4 Vine fruits
3.4.5 Shrub nuts fruits & berries
3.4.6 Flowers & bulbs
3.4.7 Vegetables & herbs

3.5.0 Seasonal horticulture
3.5.1 Fruits
3.5.2 Nuts
3.5.3 Flowers & bulbs
3.5.4 Vegetables & herbs

4 Production from Irrigated Agriculture and Plantations

4.1.0 Irrigated plantation forestry
4.1.1 Irrigated hardwood production
4.1.2 Irrigated softwood production
4.1.3 Irrigated other forest production
4.1.4 Irrigated environmental

4.2.0 Irrigated modified pastures
4.2.1 Irrigated woody fodder plants
4.2.2 Irrigated pasture legumes
4.2.3 Irrigated legume/grass mixtures
4.2.4 Irrigated sown grasses

4.3.0 Irrigated cropping
4.3.1 Irrigated cereals
4.3.2 Irrigated beverage & spice crops
4.3.3 Irrigated hay & silage
4.3.4 Irrigated oil seeds
4.3.5 Irrigated sugar
4.3.6 Irrigated cotton
4.3.7 Irrigated tobacco
4.3.8 Irrigated legumes

4.4.0 Irrigated perennial horticulture
4.4.1 Irrigated tree fruits
4.4.2 Irrigated oleaginous fruits
4.4.3 Irrigated tree nuts
4.4.4 Irrigated vine fruits
4.4.5 Irrigated shrub nuts fruits & berries
4.4.6 Irrigated flowers & bulbs
4.4.7 Irrigated vegetables & herbs

4.5.0 Irrigated seasonal horticulture
4.5.1 Irrigated fruits
4.5.2 Irrigated nuts
4.5.3 Irrigated flowers & bulbs
4.5.4 Irrigated vegetables & herbs

5 Intensive Uses

5.1.0 Intensive horticulture
5.1.1 Shadehouses
5.1.2 Glasshouses
5.1.3 Glasshouses (hydroponic)

5.2.0 Intensive animal production
5.2.1 Dairy
5.2.2 Cattle
5.2.3 Sheep
5.2.4 Poultry
5.2.5 Pigs
5.2.6 Aquaculture

5.3.0 Manufacturing and industrial

5.4.0 Residential
5.4.1 Urban residential
5.4.2 Rural residential

5.5.0 Services
5.5.1 Commercial services
5.5.2 Public services
5.5.3 Recreation and culture
5.5.4 Defence facilities
5.5.5 Research facilities

5.6.0 Utilities
5.6.1 Electricity generation/transmission
5.6.2 Gas treatment, storage and transmission

5.7.0 Transport and communication
5.7.1 Airports/aerodromes
5.7.2 Roads
5.7.3 Railways
5.7.4 Ports and water transport
5.7.5 Navigation and communication

5.8.0 Mining
5.8.1 Mines
5.8.2 Quarries
5.8.3 Tailings

5.9.0 Waste treatment and disposal
5.9.1 Stormwater
5.9.2 Landfill
5.9.3 Solid garbage
5.9.4 Incinerators
5.9.5 Sewage

6 Water

6.1.0 Lake
6.1.1 Lake - conservation
6.1.2 Lake - production
6.1.3 Lake - intensive use

6.2.0 Reservoir/dam
6.2.1 Water storage and treatment
6.2.2 Reservoir - intensive use
6.2.3 Evaporation basin
6.2.4 Effluent pond

6.3.0 River
6.3.1 River - conservation
6.3.2 River - production
6.3.3 River - intensive use

6.4.0 Channel/aqueduct
6.4.1 Supply channel/aqueduct
6.4.2 Drainage channel/aqueduct

6.5.0 Marsh/wetland
6.5.1 Marsh/wetland - conservation
6.5.2 Marsh/wetland - production
6.5.3 Marsh/wetland - intensive use

6.6.0 Estuary/coastal waters
6.6.1 Estuary/coastal waters - conservation
6.6.2 Estuary/coastal waters - production
6.6.3 Estuary/coastal waters - intensive use

ALUM CLASS DEFINITIONS

The following definitions apply to ALUM terms.

1. Conservation And Natural Environments

Land used primarily for conservation purposes, based on the maintenance of the essentially natural ecosystems present. A relatively low level of human intervention is involved, with the anticipated consequence of minor change to natural ecosystems. The land may be formally reserved by government for conservation purposes, or conserved through other legal or administrative arrangements. Areas may have multiple uses, however nature conservation is the prime use. Some land may be unused as a result of a deliberate decision of the government or landowner, or due to circumstance.

1.1 Nature conservation. Tertiary classes 1.1.1 – 1.1.6 are based on the Collaborative Australian Protected Areas Database (CAPAD) classification (Cresswell and Thomas 1997). Land under forms of nature conservation protection that fall outside the scope of the CAPAD classification, including heritage agreements, and voluntary conservation arrangements, etc. may be classified as 1.1.7 'Other conserved area'.

1.2 Managed resource protection. Tertiary classes 1.2.1 – 1.2.4 are based on the CAPAD classification. These areas are managed primarily for the sustainable use of natural ecosystems. Land managed primarily for traditional indigenous use is classified as 1.2.5 'Traditional indigenous uses'.

1.3 Other minimal use. Land that is largely unused (in the context of the prime use) as a result of a deliberate decision by the manager or the result of circumstance. Natural areas allocated to field training, weapon testing and other field defence uses are classified as 1.3.1 'Defence'. Land under native cover, where there is no applicable prime use, indeterminate use, or non-production or environmental uses is classified as 1.3.3 'Remnant native cover'. Livestock may occasionally graze 'Remnant native cover' but where grazing takes place on a regular or semi-regular basis and this is the intended prime use for the land, 2.1 is the appropriate class. This class also includes unusable land such as cliffs and rock faces. Land under rehabilitation or unused because of weed infestation, salinisation, or erosion is included in 1.3.4 'Rehabilitation'.

2. Production From Relatively Natural Environments

Land used primarily for primary production based on limited change to the native vegetation. The structure of the native vegetation generally remains intact despite deliberate use, although the floristics of the vegetation may have changed markedly.

2.1 Grazing natural vegetation. Land uses based on grazing of native vegetation by domestic stock with limited or no attempt at pasture modification. Some change in species composition may have occurred, but the structure of the native vegetation will be essentially intact.

2.2 Production forestry. Commercial production from native forests and related activities on public and private land. Environmental and indirect production uses associated with retained native forest (eg prevention of land degradation, wind breaks) are included under 1. 'Conservation and natural environments'.

3. Production From Dryland Agriculture And Plantations

Land in this class is used mainly for primary production, based on dryland farming systems. Native vegetation has largely been replaced by introduced species through clearing, the sowing of new species, the application of fertilisers or volunteer species.

3.1 Plantation forestry. Land on which plantations of trees or shrubs have been established for production or environmental and resource protection purposes. This includes farm forestry. Where planted trees are grown in conjunction with pasture, fodder or crop production class allocation should be made on the basis of prime use (with or without multiple class attribution). See Table 1 for Tertiary level classes.

3.2 Grazing modified pastures. Pasture and forage production, both annual and perennial, based on a significant degree of modification or replacement of the initial native vegetation. Land under pasture at the time of mapping may be in a rotation system so that at another time the same area may be cropped. Land in a rotation system should be classified according to the land use at the time of mapping. (See Table 1 for suggested Tertiary classes).

3.3 Cropping. Land under cropping. This land may also be part of a crop/pasture or other rotation system, but should be classified according to the use at the time of mapping. Fodder production is treated as a crop if mechanically harvested. It is suggested that Tertiary classes be based on commodities / commodity groups that relate to Australian Bureau of Statistics (ABS) agricultural commodity categories (see Table 1).

3.4 Perennial horticulture. Crop plants living for more than two years that are intensively cultivated, usually involving a high degree of nutrient, weed and moisture control. Suggested Tertiary classes are based on ABS' horticultural commodity categories (see Table 1).

3.5 Seasonal horticulture. Crop plants living for less than two years that are intensively cultivated, usually involving a high degree of nutrient, weed and moisture control. Suggested Tertiary classes are based on ABS' horticultural commodity categories (Table 1).

4. Production From Irrigated Agriculture And Plantations

This class includes agricultural land uses where water is applied to promote additional growth over normally dry periods, depending on the season, water availability and commodity prices. It includes land that receives only one or two irrigations per year, as well as areas that rely on irrigation for much of the growing season. Land parcels should be assigned to this class if infrastructure for irrigation is located in the parcel, although the land may be temporarily unused or put to alternative uses such as livestock grazing. Suggested tertiary categories are shown in Table 1.

4.1 Irrigated plantation forestry. Land on which irrigated plantations of trees or shrubs have been established for production or environmental and resource protection purposes. This includes farm forestry.

4.2 Irrigated modified pastures. Irrigated annual and perennial pastures where production is based on a significant degree of modification or replacement of the native vegetation. This class may include land in a rotation system that at other times may be under cropping.

4.3 Irrigated cropping. Land under irrigated cropping, including land in a rotation system that at other times may be under pasture.

4.4 Irrigated perennial horticulture. Irrigated crop plants living for more than two years that are intensively cultivated, usually involving a relatively high degree of nutrient, weed and moisture control.

4.5 Irrigated seasonal horticulture. Irrigated crop plants living for less than two years that are intensively cultivated, usually involving a relatively high degree of nutrient, weed and moisture control.

5. Intensive Uses

Land subject to substantial modification, generally in association with closer residential settlement, commercial or industrial uses. The level of intervention may be sufficiently high as to completely remodel the natural landscape — the vegetation, surface and groundwater systems and the land surface.

5.1 Intensive horticulture. Intensive forms of plant production, including shadehouses, glasshouses, and hydroponic cultivation.

5.2 Intensive animal production. Agricultural production facilities such as feedlots and piggeries may be included as Tertiary classes.

5.3 Manufacturing and industrial. Factories, workshops, foundries, and construction sites, including the processing of primary produce eg sawmills, pulp mills, abattoirs, etc.

5.4 Residential. Land used for residential purposes. If rural land is managed as a hobby farm, it should assigned to 5.4.2 'Rural residential'. The size of rural allotments or local government zoning plans may be useful indicators of rural residential land use.

5.5 Services. Land allocated to the provision of commercial or public services resulting in substantial impact on the natural environment. Where services are provided on land that retains natural cover an appropriate classification under 1. 'Conservation and Natural Environments' should be applied.

5.6 Utilities
5.7 Transport and communication
5.8 Mining
5.9 Waste treatment and disposal. Waste material and disposal facilities associated with industrial, urban and agricultural activities.

6. Water

Although water features are normally classified as a land cover types, their inclusion in the land use classification is essential because of their importance for natural resources management and as points of reference in the landscape. At the secondary level the classification identifies water features, both natural and artificial. Tertiary classes relate to intensity and purpose of use. Water classes may not be mutually exclusive with other land use classes. Generally, water classes should take precedence so that, for instance, a lake in a conservation reserve will be classed as 6.1 'Lake' or 6.1.1 'Lake - conservation' rather than 1.1 'Nature conservation'. Secondary and Tertiary classes are detailed in Table 1.

APPENDIX 2 DATA SPECIFICATIONS

Data Format and Spatial Referencing

Final data format	ARC/INFO polygon coverage
Coordinate system	Geographic with GDA94 datum Spheroid GRS1980 Projection geographic Units dd (decimal degrees) Datum GDA94

Data Structure

The recommended data structure for land use datasets provides for the attribution of land use polygons with information about

- the prime land use (represented by ALUM code and associated descriptor),
- the primary information source (scale, date, and reliability - ie information type),
- secondary or 'ancillary' land uses (optional), and
- a working code (optional) relating information about particular land use and classification issues.

The data structure for the Northern Territory Project is shown below.

Attribute	Format[1]	Description	Example
LAISKEY[2]	C 15 15	LAIS key - unique NT land parcel identifier	0055 12345
Lu_code	C 8 8	ALUM land use code for "Principle" land use for polygon.	4.5.1
Lu_description	C 36 36	Description of ALUM land use	Irrigated tree fruits
Source_scale	C 8 8	Scale of source data	1:100,000
Source_date	D 8 10	Date of currency/capture of spatial feature (eg. airphoto, satellite image)	xx/xx/xxxx (day/month/year)
Reliability	B 4 5	Reliability of attribute	1 = field mapping/local knowledge 2 = ancillary dataset 3 = air photo 4 = SPOT imagery 5 = Landsat ETM/TM 6 = other
Luc_date	D 8 10	Date of land use code	xx/xx/xxxx (day/month/year)
Luc_1_prop	F 4 4 (2 dec)	Proportion of parcel related to land use	0.5
Area_Luc_1	F 4 4 (2 dec)	Calculated from proportion of parcel related to land use	Square meters
Luc_2	C 8 8	ALUM land use code (Luc_2)	4.5.1
Luc_2_desc	C 36 36	Description of ALUM land use (Luc_2)	Irrigated tree fruits
Luc_2_prop	F 4 4 (2 dec)	Proportion of parcel related to land use	0.5
Area_Luc_2	F 4 4 (2 dec)	Calculated from proportion of parcel related to land use	Square meters
Luc_3	C 8 8	ALUM land use code (Luc_3)	4.5.1
Luc_3_desc	C 36 36	Description of ALUM land use (Luc_3)	Irrigated tree fruits
Luc_3_prop	F 4 4 (2 dec)	Proportion of parcel related to land use	0.5
Area_Luc_3	F 4 4 (2 dec)	Calculated from proportion of parcel related to land use	Square meters
Sum_prop	F 4 4 (2 dec)	Sum of proportion for Luc_1, Luc_2 & Luc_3	Must = 1

[1]ArcInfo item definition
[2]Not included in BRS dataset

Accuracy

Data Resolution Specifications

Scale of mapping	**1:25,000***	**1:50,000**	**1:100,000**	**1:250,000**
Surface area of the smallest mapped feature				
field area	0.25ha	1ha	4ha	25ha
graphic area	2x2mm	2x2mm	2x2mm	2x2mm
Minimum width for linear features				
field area	25m	50m	100m	250m
graphic width	1mm	1mm	1mm	1mm

* Used as standard for Northern Territory Dataset.

Spatial Precision Specifications

Positional accuracy				
vector	Graphical deviation from source material should not exceed 0.5mm at the nominated scale of mapping (50m at 1:100,000 scale)			
raster	Image rectification at 0.5 pixel root mean square, absolute image displacement at 4 pixels			
Raster processing	No greater than original pixel size			
Vector tolerances	*Fuzzy tolerance (m)*	*Snap distance (m)*	*Weed (m)*	*Grain (m)*
at 1:100,000	5.080	50.8	50.8	50.8
at 1:50,000	2.540	25.4	25.4	25.4
at 1:25,000*	1.270	12.7	12.7	12.7
Output extent	extent of map sheets covering project area plus 1 km on all sides for edge-matching**			

* Used as standard for Northern Territory Dataset.

** No buffer for the Northern Territory was created as interstate data not available

Thematic or Attribute Accuracy

The required attribute accuracy for land use mapping is greater than 80 %. The validation procedure is described in outlined in 'Part F *Land use mapping procedure*', (v) Validation - 'Land Use Mapping at Catchment Scale: Principles, Procedures and Definitions', Edition 2 (BRS, 2002).

APPENDIX 3 METADATA

LUMP Northern Territory Metadata

(Based on ANZLIC Metadata Standards, version 2, February 2001)

Category	Element	Definition of Element
Dataset	Title	Land Use Mapping of the Northern Territory
Custodian	Custodian	Dept of Infrastructure, Planning and Environment (DIPE)
	Jurisdiction	Northern Territory
Description	Abstract	This dataset contains land use classes for the Northern Territory. Land use was allocated in accordance with the "Australian Land Use and Management Classification (ALUMC Version 5)". Mapping was carried out in accordance with "Land Use Mapping at Catchment Scale: Principles, Procedures and Definitions (Edition 2)" (BRS,2002). Land use was obtained from local knowledge, aerial photographs, satellite imagery, ancillary datasets and fieldwork. The Northern Territory was mapped at three (3) scales, depending upon the intensity of land use and the resolution needed by likely clients of this dataset. The Peri-urban Intensive Agricultural and Urban Zones around Darwin, Katherine and Alice Springs were mapped at 1:25,000; the Northern Agricultural Zone mostly comprising the Katherine-Daly Region was mapped at 1:100,000; whilst the Pastoral Zone and the remainder of the Northern Territory was mapped at a scale of 1:250,000. For mapping of the Peri-urban Intensive Agricultural Zone two (2) additional land use code fields (Luc_2 and Luc_3) were used to record multiple land uses and attributed using ALUMC Version 5. A proportional value of the areal extent for each land use is included in a separate field. Water bodies (lakes, rivers, swamps, reservoirs and dams) and rivers (watercourse_a) from the Auslig Geodata Topo-250k Series 1& 2 were in incorporated within the 1:25,000 and 1:100,000 scale mapping areas.
	Search Word	Agriculture, Land Use Mapping, Land Use Classification, Land Use Maps, Land Management
	Geographic Extent Name	Northern Territory, Australia
	GEN Category	Northern Territory, Australia
	GEN Custodial Jurisdiction	Australia, Northern Territory
	GEN Name	Northern Territory, Australia
	Geographic Extent Polygon	Xmin = 129.001 Xmax = 137.999 Ymin = -25.999 Ymax = -10.999
	Geographic Bounding Box	Xmin = 129.001 Xmax = 137.999 Ymin = -25.999 Ymax = -10.999
	North Bounding Latitude	-10.999 deg
	South Bounding Latitude	-25.999 deg
	East Bounding Longitude	129.001 deg
	West Bounding Longitude	137.999 deg
Data Currency	Beginning date	1994
	Ending date	20 Oct 2002
Dataset Status	Progress	Completed
	Maintenance	Unknown/irregular

Category	Element	Definition of Element
	and Update Frequency	
Access	Stored Data Format	DIGITAL Arc/Info (Version 8.2)
	Available Format Type	DIGITAL MapInfo (Version 7.0) Arc/Info (Version 8.2) NON DIGITAL Maps
	Access Constraint	Land use mapped should be regarded as a REPRESENTATION of land use/management only, and is best used at a regional level. No responsibility is accepted for use of this information. A data agreement may be required and a fee may be applicable. Digital data available for online access only within the Northern Territory Government contains (Land Administration Information System) LAIS information that is linked to the Northern Territory Cadastre.
Data Quality	Lineage	A copy of the Northern Territory Digital Cadastre (dated 05Dec01) was obtained from Northern Territory Land Information System (NTLIS) as an Arc/Info coverage in GDA94. FME (Feature Manipulation Engine) 2002 was used by NTLIS to translate the original Microstation .dgn file to the Arc/Info coverage. Horizontal positional accuracy of the Arc/Info coverage was determined by 10 survey control points in the Darwin, Casuarina, Palmerston, Humpty Doo and Alice Springs areas – accuracy of the cadastre was within 0.25 secs of arc for all survey points. The dataset was split along longitude 132^0east and reprojected into GDA94 MGA Zones 52 and 53. The MGA94-52 coverage was then clipped into eight (8) coverages for mapping. Six (6) coverages based on the Auslig 1:100,000 series topographic maps of Darwin (5073), Koolpinyah (5173), Mary River (5272), Fog Bay (4972), Bynoe (5072), Noonamah (5172) for mapping at 1:25,000. The Northern Agricultural Zone mostly comprising the Douglas Daly Basin was clipped from the MGA94-52 & 53 coverages to include all or part of the following Auslig 1:250,000 scale topographic map sheets – Katherine (SD53-09), Pine Creek (SD52-08), Cape Scott (SD52-07) & Fergusson River (SD52-12). The balance of the Territory was mapped as two (2) coverages at 1:250,000. The Peri-urban Intensive Agricultural Zones covering parts of the Katherine (5369), Manbulloo (5368) and Alice Springs (5659) topographic map sheets were not clipped from the larger covers. The latest available scanned digital aerial photographs were obtained for the Peri-urban Intensive Agricultural Zones from NTLIS. These were ortho-rectified using the Northern Territory cadastre and a generated DEM, then mosaiced in ER Mapper 6.2. RMS errors were less than 5m. Throughout the project area the Australian Greenhouse Office Year 2000 mosiac of LandSat 7 ETM imagery was utilised where aerial photography was not available. Some areas of the Peri-urban Intensive Agricultural Zone and Northern Agricultural Zone were mapped using fieldwork. Attribute fields were populated using land use data obtained from, image interpretation, fieldwork, local/expert knowledge and other ancillary digital datasets. Roads and railways were attributed from the cadastre. Roads and coastal rivers are open polygons in the Northern Territory cadastre and were closed off by the project team. Conservation areas were attributed using the cadastre and PWCNT maps. Water bodies were attributed from the Auslig Geodata Topo-250k Series 1& 2 that was unioned with the 1:25,000 and 1:100,000 scale mapping. Urban areas were mapped from the cadastre and Northern Territory Valuer-General data. Indigenous land use was attributed from the cadastre.

Category	Element	Definition of Element
		Grazing was attributed using cadastre, imagery and local knowledge. During the verification, remapping and validation phases of the project, draft maps were assessed by Northern Territory Government personnel with local knowledge of the Katherine, Darwin and Alice Springs regions who had not been involved in the original mapping. On verification the individually mapped coverages were unioned in Arc/Info 8.2 and reprojected in GDA94 geographics. All attribution was undertaken in accordance with the Australian Land Use and Management Classification (Version 5), however two additional classes were added to satisfy the conditions within the Northern Territory. These were 1.3.5 "NT rural" for rural living on blocks predominantly covered by remnant native cover (<90%) with no agricultural development and 4.4.8 "Cleared" for areas cleared in preparation for horticulture.
	Positional Accuracy	Northern Territory Cadastre: Horizontal accuracy for urban and peri-urban zone +/- 1 to 2m, Pastoral zone +/- 1000m. (Source: Northern Territory Spatial Data Directory metadata for the Digital Cadastral Database of the Northern Territory). Positional accuracy was checked against "Survey Control Points" supplied NTLIS (See 'Lineage' above). Geodata Topo-250k Series 1 & 2: Horizontal accuracy +/- 300m (Source: Geoscience Australia website)
	Attribute Accuracy	In accordance with "Land Use Mapping at Catchment Scale: Principles, Procedures and Definitions (Edition 2)" (BRS,2002), overall attribute accuracy is > 80%.
	Logical Consistency	Arc/Info 8.2 used to check for non-labelled polygons. The dataset is topologically correct.
	Completeness	Complete
Contact Information	Contact Organisation	Dept of Infrastructure, Planning and Environment (DIPE)
	Contact Position	Principal Scientist Natural Systems Division
	Mail Address	PO Box 30
	Locality	Palmerston
	State	Northern Territory
	Country	Australia
	Postcode	0831
	Telephone	08 8999 4579
	Facsimile	08 8999 3667
	Electronic Mail Address	Dave.howe@nt.gov.au
Metadata Date	Metadata Date	02 January 2003
Additional Metadata	Additional Metadata	For further information consult the Northern Territory Spatial Data Directory (NTSDD) and Geoscience Australia websites.

APPENDIX 4 NORTHERN TERRITORY PROJECT ERROR MATRIX

Lu_codes	1.2.2	1.2.5	1.3.0	1.3.1	1.3.3	1.3.4	1.3.5	2.1.0	3.2.0	3.2.1	3.2.4	3.3.0	4.2.0	4.3.0	4.3.1	4.4.0	4.4.1	4.4.8	5.1.0	5.2.2	5.2.4	5.2.6	5.3.0	5.4.1	5.4.2	5.5.1	5.5.2	5.5.3	5.5.4	5.5.5	5.6.0	5.7.1	5.7.3	5.7.4	5.7.5	5.8.2	6.1.0	6.2.2	6.3.0	6.4.1	6.5.0	6.5.1	6.5.2	6.6.3	Row total	Row %
1.1.0					1																																						1	0.00
1.1.7			1		2																																						3	0.00
1.2.2	2				1																																						3	66.67
1.2.5		12																																									12	100.00
1.3.0			36		5				1	1							1							1				1		1		2											49	73.47
1.3.1				3			1																																				4	75.00
1.3.3			3		1713		1	4		2				1		1	1	3						2			1																1732	98.90
1.3.4			1		19	2				1				1			2	7					1									3			3								40	5.00
1.3.5					202		62	1								2		8																2								277	22.38
2.1.0			2		1			90		3																																	96	93.75
3.2.0		2			1			1	6				5					3																									18	33.33
3.2.1										25		1																															26	96.15
3.2.4											1		2																															3	33.33
3.3.0										1		0					2																											3	0.00
3.3.3					1				3					1			1	4																									10	0.00
3.4.0																	1																											1	0.00
3.5.0					3												1																											4	0.00
4.2.0													1																															1	100.00
4.3.0														4																															4	100.00
4.3.1															2																													2	100.00
4.4.0					2											6																													8	75.00
4.4.1					2			1								6	276	12						1																				298	92.62
4.4.4																	1																													1	0.00
4.4.8					15								1				5	33																		2								56	58.93
4.5.0					1												11	1																											13	0.00
4.5.1			1																																									1	100.00
5.1.0																			2																											2	100.00
5.1.1							2																																					2	0.00
5.2.2																				1																										1	100.00
5.2.4																					5																									5	100.00
5.2.6																						2																									2	100.00
5.3.0			1							1													7																							9	77.78
5.4.1			1		1																			35	2			1																40	87.50
5.4.2					69		13	1	3		3		2				5	8							29			1																134	21.64
5.5.1							1											1						1		20	1	1																25	80.00
5.5.2			2		1																						33																		36	91.67
5.5.3			2		5		1																				4	13																25	52.00
5.5.4																													13																13	100.00
5.5.5																														2															2	100.00
5.6.0					1																										16			1										18	88.89
5.6.1																															1														1	0.00
5.7.1																								1		1			1			2													5	40.00
5.7.2			1		3												1															2													7	14.29
5.7.3																																19													19	100.00
5.7.4																																	2												2	100.00
5.7.5																										1	1		1		1			9											13	69.23
5.8.0					1																																								1	0.00
5.8.2					1																														13				1					15	86.67
5.9.0																																			1										1	0.00
6.0.0					1																										1					12								14	85.71
6.2.2																																					2								2	100.00
6.3.0					6																																	9							15	60.00
6.4.1																																								2						2	100.00
6.4.2					9																																								9	0.00
6.5.0																																									11	1				12	91.67
6.5.1																																										4				4	100.00
6.5.2																																											1			1	100.00
6.6.3																																												4		4	100.00
Col total	2	14	51	3	2067	2	81	98	13	34	4	1	11	7	2	15	308	80	2	1	5	2	7	38	35	22	39	17	16	2	20	2	26	2	10	21	12	2	9	2	12	5	1	4	3107	NT
Col %	100.00	85.71	70.59	100.00	82.87	100.00	76.54	91.84	46.15	73.53	25.00	0.00	9.09	57.14	100.00	40.00	89.61	41.25	100.00	100.00	100.00	100.00	100.00	92.11	82.86	90.91	84.62	76.47	81.25	100.00	80.00	100.00	73.08	100.00	90.00	61.90	100.00	100.00	100.00	100.00	91.67	80.00	100.00	100.00	Overall	81.82

APPENDIX 5 DATA QUALITY STATEMENT

DATA QUALITY STATEMENT

Data set details

Coverage name:	Lumpnt_23dec	Type:	Coverage
Date:	6/01/02	Size:	85 MB
Stored on:	/data/lms/lcov/lcov2/workspace/landuse_final/nt/nt_final3	Custodian:	DIPE.
Contact officer:	Graeme Owen	Contact phone:	08 8999 4586
Contact address:	PO Box 30 Palmerston, NT	E-mail:	

Compliance with specifications
(for more detail see http://www.affa.gov.au - links to BRS, Landscape Management Sciences, Land Use and Land Management Practices Mapping for Australia)

		Details of Compliance	✓/✖
Metadata	ANZLIC Page 0		✓
	Report		✓
	Map		✓
Spatial data standards	Topology		✓
	Attributes		✓
	Labelling		✓
	Errors		
	Lookup tables	None	
	Tolerances	Fuzzy = 0.00V Dangle = 0.000 N	✓
	Unique IDs		✓
Classification	Global Map		
	Forestry		
	National Land Use		
	CAPAD		✓
Spatial referencing systems	Projection	Geographic wgs84, wgs84	✓
	Position		
	Overlap		
Data transfer standards	Transfer file	lump21jan_brs.e00	✓
	Media	cd	✓
Validation	File		✓
	Accuracy		✓

Assessment of data formats and structure:

Assessment of classification:

Compliance requirements:	✓/✖

Data compliance

Compliant ~~/ not yet compliant~~

Checked by: Vivienne Bordas Date29/1/03

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Bureau of Rural Sciences
PO Box E11
Kingston ACT 2604

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APPENDIX 6 NORTHERN TERRITORY DATASETS

Source Date	Dataset / Locality Name	Scale	Description
01-Jan-94	Topo250k Series 1 and 2	1:250:000	Auslig - Topo250k Series 1 and 2 - Hydro
01-Jun-95	ALCC NT Dataset	1:100,000	Australian Land Cover Change, Northern Territory dataset
30-Aug-97	Darwin Rural (south) Locality	1:20,000	Aerial Photographs - orthorectified and mosaiced by Project Team
11-Sep-97	Lake Bennett	1:20,000	Aerial photographs - Darwin Rural (south) Locality not mosaiced
08-Oct-97	Ti Tree	1:10,000	Airphotos - spot
11-Nov-97	Darwin Rural (south) Locality	1:20,000	Aerial Photographs - orthorectified and mosaiced by Project Team
27-Apr-98	Katherine 1998 Flooding	1:25,000	Aerial Photographs - orthorectified and mosaiced by Project Team
19-Jul-98	Cutta Cutta Caves Area	1:10,000	Aerial Photographs - orthorectified and mosaiced by Project Team
13-Jul-99	Middle Point Road	1:10,000	Aerial Photographs - orthorectified and mosaiced by Project Team
08-May-00	Lambell's Lagoon	1:20,000	Aerial Photographs - orthorectified and mosaiced by Project Team
08-May-00	Darwin River Area	1:20,000	Aerial Photographs - orthorectified and mosaiced by Project Team
17-May-00	Marrakai	1:20,000	Aerial Photographs - orthorectified and mosaiced by Project Team
01-Jun-00	Year 2000 Mosaic - Northern Territory	1:250,000	Landsat Satellite imagery: Year 2000 Mosaic - Aust Greenhouse Office
22-Aug-00	Darwin/Mary River	1:250,000	Landsat Satellite imagery: Darwin/Mary River
09-Jul-01	Yarrawonga - Howard Springs	1:10,000	Aerial Photographs - orthorectified and mosaiced by Project Team
09-Jul-01	Girraween	1:10,000	Aerial Photographs - orthorectified and mosaiced by Project Team
10-Jul-01	Sunday Creek	1:10,000	Aerial Photographs - orthorectified and mosaiced by Project Team
13-Jul-01	Gunn Point Access Corridor	1:10,000	Aerial Photographs - orthorectified and mosaiced by Project Team
13-Jul-01	Gunn Point Access Corridor	1:10,000	Aerial Photographs - orthorectified and mosaiced by Project Team
31-Jul-01	Noonamah	1:20,000	Aerial Photographs - orthorectified and mosaiced by Project Team
05-Dec-01	NT Digital Cadastre	1:20,000	Supplied by Northern Territory Land Information Service
15-Jan-02	Local	1:20,000	Field site visit / expert knowledge
01-Mar-02	Local	1:20,000	Field site visit / expert knowledge
04-Mar-02	Local	1:20,000	Field site visit / expert knowledge
05-Mar-02	Local	1:20,000	Field site visit / expert knowledge
27-Mar-02	Local	1:20,000	Field site visit / expert knowledge
23-Apr-02	Northern Territory Valuer General's dataset	1:20,000	Supplied by Northern Territory Land Information Service
01-May-02	Local	1:20,000	Field site visit / expert knowledge
15-May-02	Local	1:20,000	Field site visit / expert knowledge
01-Jul-02	Local	1:20,000	Field site visit / expert knowledge
01-Aug-02	Local	1:20,000	Field site visit / expert knowledge
20-Oct-02	Local	1:20,000	Field site visit / expert knowledge
07-Jan-03	Local	1:20,000	Field site visit / expert knowledge