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AGRICULTURAL LAND USE PLANNING

A guideline to identifying important agricultural lands in NSW

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Cover image: Important grazing and cropping land in the Blayney, Orange and Cabonne local government areas, NSW Department of Primary Industries, 2012.

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Disclaimer: The information contained in this publication is based on knowledge and understanding at the time of writing (April 2017). However, because of advances in knowledge, users are reminded of the need to ensure that information upon which they rely is up to date and to check currency of the information with the appropriate officer of the Department of Primary Industries or the user's independent adviser.

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Abbreviations

ACS	Agriculture commodity survey
ABARES	Australian Bureau of Agricultural and Resource Economics and Sciences.
ABS	Australian Bureau of Statistics
AIP	Agricultural industry profiles
ALC	Agricultural land classification
ALUM	Australian land use and management classification.
ARMS	Agriculture resource management survey
BSAL	Biophysical strategic agricultural land
CIC	Critical industry clusters
IAL	Important agricultural land
LEP	Local environmental plan
LGA	Local government area
LSC	Land and soil capability
LUMAP	NSW land use mapping program
MCAS-S	Multi-Criteria Analysis Shell for Spatial Decision Support software tool
NSW DIPNR	NSW Department of Infrastructure, Planning and Natural Resources
NSW DoP	NSW Department of Planning
NSW DPE	NSW Department of Planning and Environment
NSW DP&I	NSW Department of Planning and Infrastructure
NSW DPI	NSW Department of Primary Industries
NSW OEH	NSW Office of Environment and Heritage
Pilot project	NSW DPI pilot mapping project
REACS	Rural Environment and Agriculture Commodity Survey
RLC	Rural land capability
SAL	Strategic agricultural land
SCALD	NSW standard classification for attributes of land
WMA	*Water Management Act 2000*
WA	*Water Act 1912*

Foreword

Planning for rural land requires a clear understanding not only of the biophysical resources and climate, but also the nature and extent of enterprises, the contribution made by farming, and the location of important infrastructure and value adding industries.

Rural land supports primary production that also includes forestry, mining and energy generation (wind, geothermal and solar farms). There are also demands on rural land from residential development. In some instances, agriculture risks being disregarded for its contribution to the economy and social structures, and displaced by other land uses assumed to provide greater benefits.

Governments now increasingly require an evidence base upon which to develop policy, especially land use planning. Identifying and mapping agricultural land at the local government and regional level provides critical information that can contribute to planning for the retention and growth of agriculture. This information assists local and state governments, regional planning, and natural-resource management agencies plan for the future of rural areas.

This mapping methodology helps bring together critical information to assist in land use decision making for agricultural land.

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1. Introduction

Retaining land for agriculture supports sustainable regional development and food and fibre production and is an increasingly significant and complex issue for agricultural industries, the community and government. From a global perspective, it is estimated that farmers will have to produce 70% more food by 2050 to meet the world's expected nine billion population (Office of the Director, Agricultural Development Economic Division, Economic and Social Development 2009). Within Australia, continued pressure from mining and rapid urban expansion in metropolitan, coastal and regional areas highlights the need to identify and retain important lands for agricultural industries. There is also greater emphasis on evidence-based planning that requires factual information to inform local and regional strategic planning processes rather than simply relying on popular assumptions. Collating information on agricultural industries and mapping the resources upon which they depend is the first step to providing factual information to support land use planning decisions.

The guideline has evolved from a review of Australian and international literature and from the NSW Department of Primary Industries (NSW DPI) pilot mapping project (pilot project) undertaken within the Central tablelands and Hunter regions of NSW to identify and map important agricultural land (IAL). The mapping takes into account analysis of current land uses, biophysical, socio-economic and agricultural industry approaches. The guideline explores how mapping methods can be used either individually or in combination to produce a more comprehensive assessment. Scale is an important factor and influences the approach taken in each situation.

The guideline outlines the importance of providing clear and concise information that describes the nature and location of agricultural land and why the land is important for agriculture and related industries. Mapping information includes the economic contribution, challenges and constraints, climate change impacts, infrastructure requirements, and opportunities to provide context critical for the interpretation and application of the information for strategic land use planning.

A significant feature of this guideline is the engagement with local producers, agricultural specialists and planners to obtain and verify information on agriculture in an area. The approach recognises that agricultural industry representatives often have considerable and highly relevant local knowledge about important resources for agriculture, suitable locations for agricultural industries and the key challenges and constraints. However, this information is rarely documented or readily available to inform evidence-based strategic planning. Collating such information and identifying the most important resource combinations is an integral component in identifying IAL.

2. Purpose of this guideline

This guideline documents the factors that should be considered when developing a map with supporting information describing IAL. The information will assist decision makers to:

- develop strategic plans to retain important food and fibre production lands
- avoid land use conflicts and the associated community and environmental impacts particularly in regions where competition for land is significant
- identify the spatial variation of the implications of climate change for agricultural industries and provide appropriate strategic responses
- monitor and report on the loss of IAL, its extent and type.

The guideline will help local and state governments provide information that supports strategic planning at local, sub-regional or regional scales. When agricultural land is identified and its value and contribution is known, informed decision making about current and future land uses can occur.

Using this guideline

Information provided in this guideline is generic in nature and needs to be adapted to suit particular circumstances. The guideline has been structured so that a simple or more comprehensive approach can be implemented according to the specific needs of the project. For instance, the project may require only a current land use map in isolation or it may also need biophysical or socio-economic information overlays. There may also be a need to include agricultural industry mapping information that shows specific land requirements of agricultural industries.

The guideline is structured into a number of parts:

Part 3 provides background on the definition of IAL, methods for identifying IAL and previous approaches.

Part 4 explains what to consider when defining a project including key questions for goals and outcomes. A decision tree (Figure 1) is provided to guideline the selection of a suitable mapping approach.

Part 5 explores the different mapping approaches including their strengths and weaknesses.

Part 6 provides information on setting up the project including resources needed, defining the study area, stakeholder engagement, and gathering the necessary information.

Part 7 outlines product development and its application for strategic planning and planning policy.

Information in this document is provided to guide the user in considering an appropriate approach for their project. However, further references and research may be required to further build the project.

3. Background

NSW DPI recently investigated a new process for mapping important agricultural lands (IAL). The new mapping system needed to be:

- flexible enough to apply to projects with different purposes, scales, resources and time constraints,
- easily interpreted and applicable to local and regional scales to enable its input to strategic plans, local environmental plans and development control plans.

Previous mapping approaches developed in the 1980s and 1990s, such as agricultural land classification (ALC) and rural land capability (RLC) maps provided a useful summary of biophysical and other factors for agriculture across NSW. However, there were some limitations with these mapping approaches including quality standards and many were unsuitable for digitising. These maps were also not suitable for interpretation at the local or sub-regional level because the scale of the underlying soil maps and they were not applicable to agricultural activities that are not reliant on soils such as poultry developments.

These earlier approaches were developed for specific mapping outcomes and are fit for a purpose. Further information on these mapping approaches is available in Appendix 1. The strengths and limitations of these approaches were considered in developing this guideline and are outlined in more detail in the agricultural spatial resources guideline to be published in 2017.

To guide decision making at all levels of government, IAL is defined as

> existing or future location of local or regionally important agricultural industries or resources as mapped that is consistent with the *NSW DPI Guideline to Identifying Important Agricultural Lands in NSW*.

IAL involves four mapping products that can be developed individually or in combination depending on your planned project outcomes. These approaches are:

1. a **current land use map** that identifies where agricultural industries are located
2. a simple map of important **biophysical resources** for agriculture applicable across all agricultural industries
3. an additional extra **overlay of socio-economic** information also applicable across all agricultural industries
4. an **agricultural industry map** that identifies the location of specific agricultural industries using critical biophysical criteria, access to infrastructure and socio-economic location criteria.

Further information on the strengths and limitations of these mapping approaches is outlined in **Part 5**.

4. Defining the project

Project purpose and defined outcomes

A clear understanding of the project purpose, context and intended audience will help define the most suitable mapping approach. Project parameters must be clear and include available resources, available data, and time frames.

Project goals

The project goals will likely reflect requirements of strategic land use planning studies which need an understanding of:

- accurate information on the importance of agriculture to an area and its resource needs such as:
    - the extent and nature of agriculture in an area
    - the contribution of agriculture in terms of commodities and $ per ha
    - the infrastructure and resources required to support agriculture such as irrigation freight, saleyards, silos, transport routes
    - value adding enterprises that support agricultural producers
    - an area's biophysical constraints to agriculture.
- trends in agriculture such as enterprise switching, intensification, increase in scale, tenure, employment
- future industry development needs and where to target non-agricultural land uses
- the risk of conflicts between agriculture and other land uses, particularly urban settlement
- the impact of changing climate and markets on agricultural land use
- what is required to retain or expand local food production (such as local, organic or niche products, infrastructure, land resources, transport routes and water supply).

Decision tree

The decision tree in figure 1 assists the reader to determine what project level to choose in undertaking mapping. The decision tree in figure 2 guides the reader to identify which mapping approach to select. These decisions should be documented so the audience is clear on the decision process and the information included in the development of the maps. Metadata should also be documented as a minimum to provide clear information about the content, quality, format, location and contact information (see section 5). Any maps produced must include a clear statement of confidence to convey to the end user the level of detail or accuracy of the map.

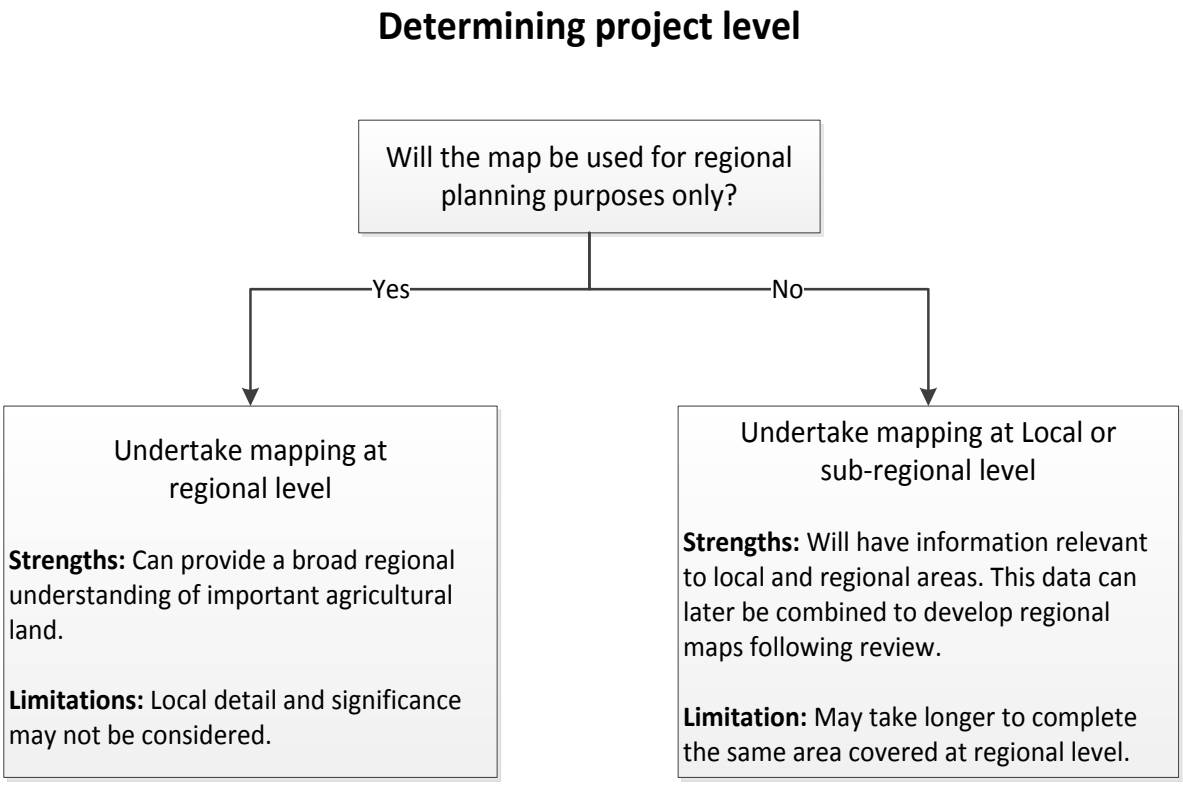

Figure 1: Decision tree to identify which level to develop the IAL maps

Note:

Local refers to a single or small group of LGAs.
Sub-regional refers to a collection of LGAs with similar characteristics such as climate, topography, key agricultural industries, shared infrastructure.
Regional refers to a large collection of LGAs typically within the NSW Planning defined regional boundaries.

Determining mapping approach

Important Agricultural Land - Industries are those that are important at the local, regional or state level either economically (eg gross domestic product or key niche industry) and/or socially (eg employment). **Important Agricultural Land - Resources** are the resources that industries rely on either natural (eg soil) and/or made (eg infrastructure)

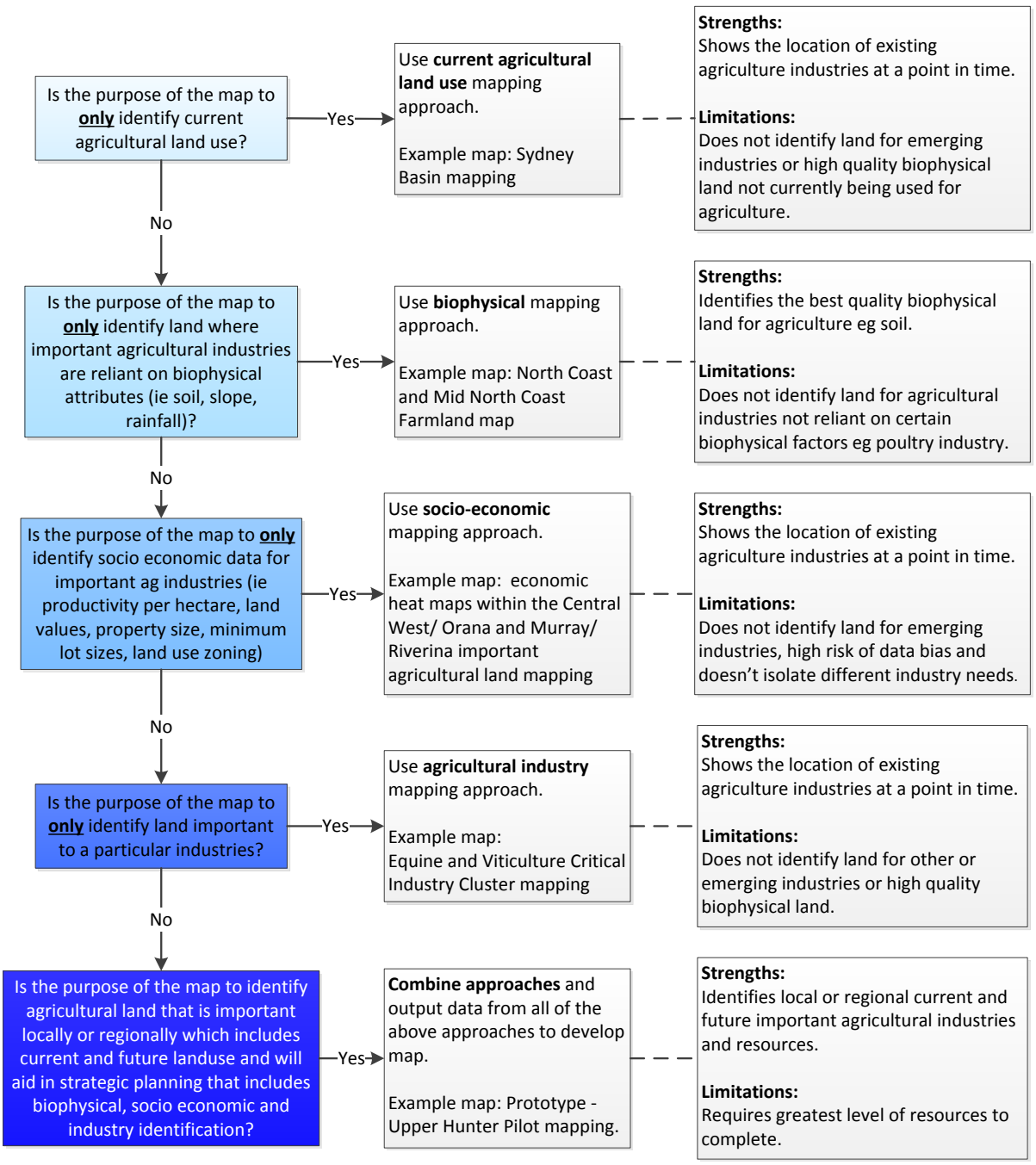

Figure 2: Decision tree to identify the best method of mapping for a specific purpose . See Appendix 1 for details on mapping approaches

5. Deciding on the important agricultural land mapping product

IAL mapping includes four products that can be used in isolation or in combination to suit the intended project. The four basic products include current agricultural land use maps, biophysical maps, socio-economic maps, and agricultural industry maps.

The approach taken will depend on project objectives, available resources, time constraints and other similar mapping undertaken in the vicinity. The strengths and limitations of the four types of products are outlined below to help you decide on the appropriate product.

a. Current agricultural land use map

A current agricultural land use map shows the location of existing agricultural enterprises at a particular point in time. This can be useful to identify the extent of clusters of similar or affiliated industries and can inform strategic planning and ultimately land use zone allocation for agriculture in local environmental plans. An example is the Sydney Basin mapping that mapped current agricultural land uses (NSW Department of Planning and Infrastructure (NSW DP&I) 2012). Further information on the Sydney Basin mapping is provided in Appendix 1.

Current agricultural land use maps may not accurately identify lands that are highly suitable for agriculture, especially for emerging agricultural industries or industries in transition. These maps do not consider the importance of high quality biophysical land as a critical resource that potentially can be lost if it is not currently used for agriculture.

b. Biophysical map

A biophysical map shows land with high quality soils and/ or other biophysical resources suitable for highly productive agricultural enterprises. The biophysical map identifies land of the highest quality with the aim of retaining it for a broad range of agricultural land uses. As well as soils, biophysical factors can include climate, water resources (rainfall, groundwater) or air quality such as measures of pollination potential.

In 2012, biophysical strategic agricultural land (BSAL) mapping was developed, driven by the need to manage growth in the mining and coal seam gas industries (NSW DP&I 2012). It identified land with the highest quality soil and water resources critical for agriculture. It focused on identifying resources with exceptional agricultural value at the state level (typically of state, national or international significance). Another example is the north-coast and mid-north-coast farmland mapping projects outlined in Appendix 1.

By identifying lands of high biophysical quality, they can be protected for agricultural purposes. Appropriate land use planning controls can assist in providing legal protection through zoning and other controls.

There are many factors that influence why a particular parcel of land is used for a specific agricultural purpose. A biophysical map may not consider all the important attributes for the location of an agricultural industry. Other factors such as markets, transport, economic advantages, infrastructure and labour are highly relevant for many agricultural industries. For instance, the proximity to processing facilities and markets for poultry farming or intensive horticulture developments such as polyhouses is critically important.

c. Socio-economic map

Socio-economic information such as agricultural production per hectare, land value, property size, critical market information, transport, infrastructure and labour requirements can help develop a greater understanding of agriculture. Providing information such as production values per hectare can potentially show areas of greater investment in agriculture.

The socio-economic information can be shown on a map in isolation, but is more useful combined with at least the biophysical map to identify areas highly valued for agriculture from both a biophysical and socio-economic perspective.

Land use planning maps such as minimum lot-size and land use zone maps can overlay socio-economic maps to indicate the accuracy of the planning policy over the subject land. Minimum lot-size information can show subdivision within a local government area (LGA), which could be compared to current farm size to show current and potential fragmentation. An overlay of land use zones can show whether the areas most suited for agriculture are zoned for primary production purposes, including areas where there is high biophysical value and high investment in agriculture.

Not all socio-economic factors need to be included. Specific socio-economic factors are chosen according to the purpose of the project.

The biophysical and socioeconomic maps provide useful information that allows decisions to be made about the retention of IAL for production.

However, there are limitations to this mapping approach because it does not consider any potential future agricultural operations. It is also generic to all agricultural industries rather than considering location requirements of specific industries that are important to the LGA or region. Understanding the location requirements of specific industries may assist in planning for the retention of IAL for current and future agribusiness development.

d. Agricultural industry map

Agricultural industry mapping shows IAL on a map that is connected to an agricultural industry. It takes into account the crucial factors of where and how agricultural industries operate and includes all agricultural industries, including non-soil based industries.

Maps showing the location of lands highly suitable for agricultural industries, for instance, will typically be defined by a distinctive combination of critical resources (such as biophysical, economic, infrastructure) important for that industry, regardless of current land usage. This approach considers the underlying drivers or reasons that influence the location of an agricultural activity. It is therefore less likely to be as time limited as the other approaches described. Land identified is highly suitable for the specific industries studied and is considered to be the ‘best of the best’ land in meeting specific location criteria for these industries.

Agricultural industry profiles (AIPs), developed in conjunction with the maps, provide background information to assist with map interpretation. The profiles should contain information on economic aspects, challenges, climate change considerations, infrastructure requirements, development prospects, opportunities and land use planning implications. This information explains the significance of the preferred location of an agricultural industry.

Single IAL maps for an LGA or region can be made by:

- combining land identified as important for individual agricultural industry areas as in the pilot project (Upper Hunter). Further information is provided in Appendix 1.
- identifying resilient land such as land highly suitable for at least two agricultural industries i.e. cropping and grazing, rather than simply one activity.

- identifying industries with high amounts of infrastructure investment as important i.e. areas of high amounts of investment in irrigation or other infrastructure.

The assumptions and decision making need to be clearly articulated when translating the land identified as important for specific industries into a single map for land use planning purposes. Using the multi-criteria analysis shell for spatial decision support (MCAS-S) software tool (or another multi-criteria analysis tool) in this approach would enable quick consideration of the impact of different factors on the final map (ABARES 2014).

Local and regional level mapping

The mapping approaches outlined above can be studied over a range of detail and areas determined by the project objectives, available resources and time frame. For the same resources, for example, local level mapping covering a smaller area may provide greater detail than can be provided for regional level mapping. Local and sub-regional planning that can potentially provide a greater level of detail is more suitable for strategic planning for local government for input into local environmental plans (LEPs).

> *Local refers to a single or small group of LGAs.*
>
> *Sub-regional refers to a collection of LGAs with similar characteristics such as climate, topography, key agricultural industries, shared infrastructure.*
>
> *Regional refers to a large collection of LGAs typically within the NSW Planning defined regional boundaries.*

Regional level mapping can provide a broad overview of agricultural information over a larger area, with the opportunity to provide further detail in specific areas of interest. This is more useful for planning over a region that requires a broad level of information. Regional planning is also suitable where there are not significant differences in the landscapes and agriculture over the LGAs.

In 2015-16, the NSW Department of Planning and Environment (NSW DPE) undertook mapping in the Orana/Central West, Murray and Murrumbidgee regions to inform the NSW DPE Regional Plans for those and other areas across NSW. The regional scale mapping approach was selected as there were many LGAs to be studied and the landscapes in those regions are relatively ubiquitous. Smaller LGAs that were not well aligned to these landscapes were not captured in the IAL mapping.

Further work to improve the NSW DPE regional planning maps would concentrate on identified localities of high productivity for example, where there may be contestation or competition from non-rural land uses. Clear evidenced-based information gives policy makers information to plan strategically and allocate appropriate land use planning zones and provisions to protect land for future agricultural production.

Other productive areas that are not at threat from urban expansion can be confidently zoned for primary production with appropriate ancillary provisions and may not require a detailed mapping project. Further information on NSW DPE's project is provided in Appendix 1.

Care also needs to be taken in studying high value agricultural industries at the regional level for application and interpretation at the local level. High value agricultural industries selected at the regional level may not be represented at the local level. Interpreting regionally produced information at the local level may result in misinformation.

Local level map development also needs to consider interface issues. For instance, if mapping in an LGA is undertaken independently of other surrounding LGAs, inconsistent mapping across adjacent LGAs may result. This could be overcome by considering an area broader than the individual LGA boundary being studied. Alternatively, a sub-regional level mapping project could be undertaken to overcome these issues.

Map scale

Regardless of the scale at which a map is viewed, its precision is determined by the quality of the data used to create the maps. Expressed as a ratio, the map scale indicates the relationship between a unit of length on a map and the length it represents on the ground.

The scale of the most critical data sets used to map agricultural land is 1:250,000. This means that 1 cm on the map corresponds to 250,000cm or 2.5 km on the ground. One square centimetre on the map corresponds to 6.25 square kilometres (625 ha) on the ground. Table 1 below outlines the relationship between map scale, ground distances and areas.

Table 1. Relationship between scale, ground distance and area

Map Scale	Ground distance (metres) represented by 1 cm on the map	Minimum mappable area (ha) represented by 40mm2 on a map
1:250,000	2.5km	625ha
1:100,000	1km	40ha
1:50,000	500m	10ha
1:25,000	250m	2.5ha
1:10,000	100m	0.4ha
1:5,000	50m	0.1ha

Source: Hulme et al 2002

The smallest area able to be accurately identified is determined from the mapping data used in the project. For instance, the smallest area that could be accurately identified on the data used for the pilot project was 250ha because of the scale of the input data. These maps are suitable for broad-scale strategic planning purposes at the local or regional level. They are not suitable for property specific planning such as assessing development proposals or spot rezoning proposals, which require a greater level of accuracy and detail on soil, water, vegetation, infrastructure etc.

Confidence maps and metadata should be provided for all maps produced to guide the user on map accuracy and details about the map. Most government agencies use the ANZLIC metadata profile and guidelines which are available from the ANZLIC website (ANZLIC 2016). Information on the purpose and definition of metadata is provided on the NSW Government's environmental data portal site, SEED (Sharing and Enabling Environmental Data) (NSW Government 2016). Two examples of NSW metadata statements can also be accessed from the reference: NSW Government 2016.

6. Developing the project

When developing the project you need to:

- define the study area
- understand the resourcing needs
- gather information and suitable data sources
- engage stakeholders,
- confirm the product.

Defining the study area

The area to be investigated and mapped can be defined on the basis of:

- land use planning areas, such as a LGA, a planning region or sub-region
- a natural resource planning unit such as a catchment management region or bio-region
- a social catchment of relevance to a particular community group such as a Landcare group, or particular industry sector (e.g. cotton growing areas)
- agro-ecological regions (Williams et al 2002) that have a similar range of environmental factors such soils, topography and climatic or market access features to support similar agricultural industries
- available data sets, resources and the time-frame available to complete the study and analyse the results.

The boundaries of the study area chosen for analysis will dictate the identification of important agricultural industries. The boundaries may include LGAs, catchment or agro-ecologic areas for example. Care should be taken not to introduce potential biases when selecting the study boundary. For example, a specific agricultural industry selected as important in a LGA may not be reflected at a broader study area level defined by a number of LGAs. Users of the product (map and/or agricultural profile information) need to be aware of the potential analytical bias caused by the selection/scale of the study area. Alternatively, a review of those industries considered important to the subset area can be included in the study.

Care needs to be taken in interpreting maps from projects drawn from beyond the study area boundary. It may be difficult or impossible to draw conclusions from varying data sets and scales. The study would need to consider how to limit or avoid those issues. The study may need to take into account the broader spatial extent of current land use, biophysical, socio-economic or agricultural industry information beyond the border of the study area to avoid interface issues.

Available resources

The resources required to undertake any mapping project are dependent on the scope of the project and funding. Each of the project components should be considered before estimating resources including:

- scoping the project
- determining whether individual or combination of mapping approaches is required
- setting up reference and working groups
- information gathering
- stakeholder engagement
- product development.

For example, the pilot project in the Central West and Upper Hunter regions used the following resources:

- a project manager
- an assisting officer
- an administrative officer
- a geographic information systems (GIS) officer
- officers to assist with workshops
- supporting staff.

The positions and their respective roles are outlined below.

Project manager

The project manager oversaw the project by establishing clear and attainable project objectives, building the project requirements, and managing the scope, time, cost and quality of the project. The manager wrote the profiles and newsletters and most of the final report. The position was part-time for six months.

Assisting officer

An assisting officer undertook relevant research, established relevant industry, agency and other contacts and assisted in the development of the products, profiles and newsletters, identifying and preparing data and the initial analysis of results. They also assisted at the stakeholder consultation workshops (further information under ‘workshops’ in this section) and helped with the development of the final report and map production. This position was part time for six months.

Administrative officer

An administrative officer organised meetings, teleconferences, catering, photocopying survey forms, copying maps and attendee lists. This position was part time for around six months.

There were greater demands prior to meetings and workshops and lesser demands at other times.

GIS officer

The GIS officer undertook the task of producing draft and final maps of IAL in a suitable format from available data and data formatting and cleaning. The Assisting officer can perform data formatting and cleaning if skills are appropriate. The GIS Officer was required full-time for around a month.

Supporting staff

Supporting staff assisted at the stakeholder consultation workshops to help participants with the interpretation of any surveys, maps or questions for the project.

Other tasks

Other tasks requiring costing include the production of the final report, AIPs or fact sheets and any other reports for publication. This cost is not large, but becomes increasingly expensive if amendments are made. Costs are greater if the final report and products are published in hard copy.

Information and suitable data sources

Quantitative and qualitative information

The quantitative information on a map will show a representation of the land considered important for agriculture. The criteria used (soils, rainfall, extent of existing enterprises, commodity value, access to infrastructure and slope etc.) and their ranges (thresholds) will determine what is considered 'highly important' agricultural land.

More information should also be provided on how the map is to be interpreted. This will depend on the end product and its use, whether it is for strategic land use planning at the local level or catchment basin wide water resource planning. A metadata statement that provides a structured description of the content, quality, condition or other characteristics of the data should be included (see section 5). It enables all people collecting, using and exchanging data to share the same understanding of its meaning and representation.

More information in the form of a report, profile document or notes on the maps themselves provides the context for the map. It allows the map to be interpreted within the intended context. Profiles or reports may include important biophysical information such as criteria and thresholds used to derive the maps. An example is provided in Appendix 1 on IAL mapping in the Lower Hunter Region of NSW.

Reports should include agricultural industry statistics, trends, economic conditions, productivity and business scale trends. Other relevant influencing factors for agricultural industries such as infrastructure (transport, saleyards, silos, abattoirs etc.), historic factors, climatic variability and change, irrigation or water availability, market types and proximity to markets where relevant to the project should also be included. More information such as zoning and identified growth corridor areas can also be useful.

This information sets the context for the maps and assists in developing an understanding of the implications of making key planning decisions in the agricultural context. It also provides background material for any analysis of competitive advantages, opportunities, outlook and strategies for agricultural investment and land use planning strategies.

Information gathering

A major part of information gathering is sourcing relevant data to:

- identify the predominant agricultural industries, important biophysical factors to identify high quality land, socioeconomic criteria and current agricultural land use in the area being studied
- validate agricultural industries, characteristics of the land and other relevant factors. This information may be sourced from biophysical, economic and agricultural industry reports, regional summaries and locally relevant intelligence from agricultural specialists, soils experts, industry representatives and other stakeholders. This information will also provide context for consultation with the reference groups and with other stakeholders/clients
- identify the most relevant criteria and statistical data to define key biophysical characteristics and/ or the most suitable locations for agricultural industries being studied
- establish the relevant scale for any maps produced (usually based on the least detailed data set) and the implications for the interpretation and use of the maps at workshops and for the final product.

Other useful information includes:

- zoning and lot size maps, future potential growth area maps
- relevant local and regional strategic planning or natural resource management reports to establish the strategic context
- an inventory of associated secondary and rural industries, if appropriate, to understand the broader (economic) extent of agriculture.

Agriculture is a diverse land use of varying agricultural industries with specific resource needs. Many agricultural land uses are highly dependent on the landscape and biophysical factors such as climate, soil, topography and access to water that determine the specific agricultural land use and its productivity.

Other important considerations for some agricultural industries include: distance to markets, historical use, infrastructure, economic and social factors. Often, intensive animal or plant industries are less dependent on biophysical factors. Other factors, such as existing industry clusters, critical industry mass, or landscape features may be more important for brand recognition and marketing. Industry clusters can also determine the availability of important associated service industries and processing plants. Other economic factors to consider include distance to processing facilities, labour availability, and critical infrastructure, such as 3-phase power, B-double truck routes and proximity to ports. Different criteria will need to be identified to define the important resource combinations and locations for distinct groups of industries and for different geographic/climatic areas.

Spatial data sets for mapping IAL

Time and resource constraints usually preclude the development of new spatial data sets. For existing data sets, their relevance and accuracy should be assessed and the relevant licence agreements secured.

Useful spatial data sets for mapping with very wide (ideally whole of NSW) coverage are listed in Table 2. These data sets support consistent and comparable mapping of IAL across local or regional areas in NSW. More specific data sets, such as those listed in Table 3 for the pilot project (Upper Hunter region) can be used where applicable.

There are a wide range of criteria to define lands of value to specific industries and regions. Selecting a limited number of state wide data sets helps to focus on the most significant criteria. For example, IAL for different agricultural industries were defined by criteria such as land capability, soil fertility and water access in the pilot project and the Lower Hunter, Central West/ Orana and Riverina/ Murray mapping projects. Specific thresholds within these criteria, such as rainfall above 650mm, were adopted to further refine the criteria for each agricultural industry. These criteria and thresholds were then mapped.

In the pilot project, the criteria and thresholds for agricultural industries were selected following interviews with former NSW DPI extension officers with expert knowledge in the field. The criteria and thresholds were further refined by agricultural industry experts. Other projects using this methodology developed criteria and thresholds by principally consulting with industry experts. For the criteria and thresholds developed for poultry industry lands in the Lower Hunter mapping project, see Table 5 in appendix 1; and for the location criteria and thresholds for agricultural industries selected in the Central West/ Orana Mapping Project, see Table 6 in appendix1.

The criteria in a particular study area may vary considerably from those in a different geographic area, as a change in one factor, such as temperature, may be offset by higher soil fertility or access to irrigation. Some criteria may not be directly transferable from one region to another.

Use the most accurate local data sets to verify important lands for local industries with unique characteristics, such as specific chill requirements for certain types of fruit.

Table 2 below contains information on useful spatial datasets for mapping projects. More detailed information on available data sets is provided in Appendix 3.

Table 2. Useful spatial datasets for identifying important agricultural lands (IAL)

Group	Data set	Date	Scale	Source
Land	Slope	2009	1:100,000	Australian Government, Department of Agriculture and Water Resources. Multi-Criteria Analysis Shell for Spatial Decision Support (MCAS-S)
	Elevation	2009	1:100,000	Australian Government, Department of Agriculture and Water Resources. Multi-Criteria Analysis Shell for Spatial Decision Support (MCAS-S)
Soils and landscapes	NSW Rural Land Capability	1986	1:100,000	NSW Office of Environment and Heritage
	NSW Agricultural Land Classification	1986	1:100,000	Former NSW Agriculture
	NSW Biophysical Strategic Agricultural Land Maps	2013	1:250,000	NSW Department of Planning and Environment
	NSW Soil Landscape Maps	Last published map 2010	1:100,000 1:250,000	NSW Office of Environment and Heritage
	NSW Land Systems Mapping	Mid 1980s	1:250,000	NSW Office of Environment and Heritage
	NSW Derived Inherent Soil Fertility of NSW	2013	1:250,000	NSW Office of Environment and Heritage
	NSW Land and Soil Capability	2008	1:250,000	NSW Office of Environment and Heritage
	Geology maps	1970s to present	1:25,000 1:50,000 1:100,000 1:250,000 1:500,000	NSW Department of Industry, Resources and Energy
Vegetation	Vegetation information system	2010 to 2014	Regional scale	NSW Office of Environment and Heritage
	Normalised difference vegetation index	Maps from 1992 Grids from 2008	Very high resolution	Australian Government, Bureau of Meteorology
Aboriginal heritage	Aboriginal Heritage Information Management System (AHIMS)	Since 1970s	Property level	NSW Office of Environment and Heritage
Planning	Local Environmental Plans (zoning information)	various	1:100,000	NSW Councils

Group	Data set	Date	Scale	Source
Water	Water sharing plans	various	Regional level	NSW Department of Primary Industries, Water.
	Irrigation districts	various	1:250,000	Private Irrigation District Authorities such as in the Hunter and Murrumbidgee regions.
	Flood maps	various	Local level	local governments
Climate	Rainfall 1961–1990 average	2012	1:500,000	Australian Government, Bureau of Meteorology
	Rainfall 1980-2008 mean monthly	2009	1:100,000	Australian Government, Department of Agriculture and Water Resources, (MCAS-S)
	Mean monthly mimimum temperature 1980-2008	2009	1:100,000	Australian Government, Department of Agriculture and Watrer Resources (MCAS-S)
	Mean monthly maximum temperature 1980-2008	2009	1:100,000	Australian Government, Department of Agriculture and Water Resources, (MCAS-S)
Administrative boundaries	Regional plan boundaries	2015	1:250,000	NSW Department of Planning and Environment
	LGA boundaries	various	1:250,000	NSW Department of Planning and Environment
Roads, rail and towns	Roads	various	1:250,000	Transport for NSW
	Rail	various	1:250,000	Transport for NSW
	Towns	various	1:250,000	NSW Department of Planning and Environment
	Transport Network Strategic Investment Tool (TraNSIT)	2015	Small and large scale	Commonwealth Scientific and Industrial Resrach Organisation (CSIRO)
Socio-economic	Land value and property information data	2001 onwards	N/A	Valuer General of NSW
	Agricultural Census data 2010-11 • Agricultural commodities, Australia, 2010-11 (cat No. 7121.0) • Value of agricultural commoditries produced, 2010-11 (cat No. 7503.0) • Australian and New Zealand Standard Industrial Classiifcation (ANZIC) employment and business turnover by Division, Sub-division and Class.	2012	N/A	Australian Government, Australian Bureau of Statistics
	Rural Environment and Agricultural Commodities Survey 2014-15 • Water Use of Australian farms, 2014-15 (cat No. 4618.0)	2014-15	N/A	Australian Government, Australian Bureau of Statistics

Table 3 Specific additional spatial datasets used for the NSW DPI pilot mapping project in the Upper Hunter region of NSW

Data set	Date	Scale	Source
Geological Maps identifying alluviums (ground water sources) such as Hunter River Alluvium Geological Map (No. Geological Survey Report No. GS 1988/051)	1988	1:100,000	NSW Department of Minerals and Energy
Viticultural Geographic Indicator regions	2011	N/A	Wine Australia / regional viticultural industry associations
Maps of existing Intensive Agricultural enterprises (such as horse studs, and viticultural enterprises or poultry sheds)	2011	N/A	local governments, industry groups or NSW Environmental Protection Authority (licencing).

Economic and statistical information

To identify leading agricultural industries, factors to consider include:

- the annual value of local production by that sector
- the total area of land utilised by the industry within the study area
- how widespread/prolific it is in a region (how many growers / graziers)
- its relative significance in terms of local agricultural output, value adding and flow-on values (e.g. regional processing and employment) and its regional, national or international significance.

Sources of useful information includes:

- Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES) statistical information including:
  - Australian Agriculture and grazing industry survey from 1989 on AgSurf (ABARES 2015)
  - Australian dairy industry survey from 1989 on AgSurf (ABARES 2015)
  - Resource Management Survey data package 1998 to 1999 (ABARES 1998)
  - Resource Management Survey Landcare and Farm Forestry Report 1998 to 1999 (ABARES 1998)
  - Natural Resource Management on Australian Farms 2006-07 (ABS 2008).
- The ABS statistical information includes the:
  - Australian Bureau of Statistics (ABS) population census (ABS 2016)
  - ABS Agricultural Census (ABS 2016)
  - ABS Rural Environment and Agricultural Commodity Survey (ABS 2014).
- NSW DPI has prepared a number of spread sheets to summarise ABS information including (NSW DPI 2016):
  - agricultural production data spread sheets from the 2006 and 2011 agricultural census
  - agricultural Commodity Profile reports from the 2006 agricultural census for the Sydney region and NSW

    - employment locations in agriculture, forestry and fisheries from the ABS 2006 Place of Work (POW) data from the population census in NSW and Sydney.
- the Commonwealth Scientific and Industrial Research Organisation (CSIRO) has produced TraNSIT to analyse both small and large scale investments in the agriculture supply chain, with current applications covering almost all Australian agricultural logistics (CSIRO 2016).

Further information on the above data sets, references and limitations of the ABS data is provided in appendix 3.

Stakeholder engagement

An important consideration is to decide what level of engagement to undertake.

Engaging stakeholders in the project will result in:

- expert local knowledge on the spatial patterns of agricultural industries and the reasons for their geographic distribution
- confirmation of current agricultural land use
- verification of high quality biophysical lands
- confirmation of key socio-economic factors and agricultural industries important to a region
- improved understanding and usage of the information once the project is completed.

Experience from other states and NSW has shown that lack of engagement, particularly with local government, significantly lessens the chances of incorporating the information into strategic planning processes, despite the quality of the information.

Stakeholders engaged in the project should represent the range of agricultural commodities and geographic locations in the study area, particularly if there is significant resource or agricultural variation. They can include professional farmers with a broad knowledge of their agricultural industry and the local area, representatives from agricultural industry bodies, local and state government employees (both planning and economic development representatives if appropriate), agricultural advisors, environmental and resource consultants, and anyone who has a sound understanding and appreciation of agriculture in the study area and strategic planning processes. Ideally, this includes people with an interest in supporting the development of informed, locally relevant strategic plans (for land use planning, industry development or for natural resource management). Data and GIS specialists may provide relevant technical input.

It is recommended that reference and working groups assist with managing the overall direction and guidance for the project. These groups can also provide input to identifying IAL at the selected scale. Engaging early with key stakeholders will assist.

Setting up reference and working groups

Reference group

A reference group can provide the overall direction and guidance for a project. It can:

- confirm the importance of biophysical and socio-economic criteria and thresholds for the project including identifying leading agricultural industries, their scale, value and location
- provide information that assists in confirming appropriate biophysical, social, economic and other factors for general agricultural land or specific agricultural industries
- confirm planning regulations and their likely impacts

- develop an understanding of the issues and other impacts facing agriculture in the region.

A reference group would likely include representatives from local and state government and key agricultural industries. NSW DPI can provide information and guidance on the development of the project as a member of the reference group or as a key stakeholder. The experience and local knowledge that reference group members can provide could be invaluable throughout a project, particularly in evaluating the integrity of spatial data and validity of outputs from any models used.

It is recommended that potential reference group members be provided with a written brief early in the process to assist them in understanding the project outcomes, expectations and time frame. A written brief should include:

- the background to the project:
    i. the purpose for the study and what outcomes will be delivered
    ii. who the study is being done for and who is involved
    iii. how the information from the study will be used
    iv. the study context (i.e. other strategic planning or mapping processes underway).
- project schedule and planned process for developing maps and associated reports
- participant commitments, such as:
    i. activities expected of participants
    ii. the time commitment required
    iii. how they will be consulted, kept informed of progress and the opportunities to provide feedback.

Working group

A working group of stakeholders may also be formed to further engage agriculture representatives and relevant community members and provide extra or more detailed input to the project. This can also serve to raise awareness of strategic land use planning issues in the broader farming community.

This group can provide expert local knowledge on the spatial patterns of agriculture and the reasons for their geographic distribution. This is especially relevant for the identification of social and economic variables, which tend to be difficult to exhibit as spatially delineated variables in datasets.

Selection of working group members can be by private invitation, or by advertising through the media. Private invitation allows specific groups to be represented and makes it easier to manage the numbers involved. It also ensures the most directly relevant people attend. Consideration should be given to the seasonal commitments of agriculture in the region and the ability of a group to participate over the study period.

The input by the working group can include:

- information on special features and the scale (including unique agricultural resource features, multipliers and/or value adding) of agriculture
- competitive advantages of the agriculture industries, such as markets or branding, if relevant
- constraints and limitations to the extent of agriculture (resource and/or production)

- relevant information sources (including historical reports) or information gaps
- future prospects for agriculture in changing circumstances, including industry changes, land use threats and a changing climate.

Engaging the working group can take the form of small group workshops, targeted meetings, surveys and/or interviews.

Structured workshops are a useful tool to enable members to consider alternative viewpoints and gather relevant information on the local context. They also help to identify the relevant mapping criteria and thresholds, locations of agriculture on maps and general agriculture knowledge.

Targeted meetings and interviews are a way to discuss issues in greater depth with the project's key stakeholders and technical specialists. Telephone interviews, surveys and liaising with relevant stakeholders are also appropriate and can be varied according to the time available, accessibility of the stakeholders, and type of engagement required. Regular briefings help keep stakeholders informed of key developments that may have implications for their strategic planning processes.

It is also important to consult with organisations that have developed or used this methodology to benefit from their experiences in implementing it.

Workshops

The aim of the workshop is to:

- gather relevant information about resources and/or socio-economic information about agriculture in the study area
- verify the combination of resources and the specific criteria that define the most important locations for the industries or agriculture generally being studied
- gain feedback on the draft maps
- keep key stakeholders informed on the mapping process and findings from preliminary data gathering (including any data constraints).

It is important to:

- ensure effective representation of the various agricultural industry groups, agriculture resource or socio-economic experts and from various parts of the study area, and avoid over representation
- ensure enough agriculture representatives can attend the meeting to make the results meaningful
- select a neutral and central venue
- time the meeting to minimise potential clashes with farm/industry commitments
- secure input from absent working members who wish to contribute and may have critical information
- facilitate the event to ensure all participants have the opportunity to contribute and deal with representatives who may see it as an opportunity for political grand standing.

Specific issues raised during the workshop may require further investigation via more out-of-session meetings with relevant members/experts. It is also important to provide feedback to working group members on the outcomes from the workshop via a newsletter or other social media.

It can be useful for local government planners and economic development officers and government advisors to attend the workshops to interact with the agricultural representatives and to contribute their knowledge on local resources and industries.

Information on the project can be communicated to broader community groups or regional/state industry representatives, government agencies and/or consultants. This can help to keep the community informed and they may also provide useful information, references, or contacts. Local government websites, newsletters, official project websites, twitter, Facebook and other social media are good avenues for disseminating information and providing the opportunity for more feedback. Media releases are a valuable way to provide information in a positive light.

Information and resources required for the workshop include:

- an overview of the project goals, process, timelines and intended products
- relevant ABS and other information on agriculture in the study area and the industries being studied
- a satellite image of the region, showing major roads, towns and key features to provide orientation and context
- maps of key resource data used to develop the draft maps (such as land and soil capability (LSC), annual rainfall patterns etc.). Using A3 size maps can help workshop members to focus on strategic planning issues
- interpreted agricultural land use information, such as pre-prepared draft map(s) of IAL for leading industries or specific socio-economic or current land use information including key criteria used.

For agricultural industry mapping, the stakeholders could be divided into agricultural industry groups. A series of questions to gather relevant information and to review and refine the maps can also assist.

Questions should reflect the project goals and intended outcomes, but could include:

- Do you agree (or not) that the agricultural industries selected are the main ones in the study area? (need a definition of main agricultural industries)
- What is the most significant contribution of each of the agricultural industries to the local community?
- What features/resources make the study area special for particular agricultural industries?
- What are the main challenges and threats to the agricultural industries in the area?
- What are the main infrastructure requirements for the industry?
- What is the future of the industry in the area?
- What are the 3-5 main criteria (biophysical, economic features etc.) that define the most important locations for the leading agricultural industries?
- Do the draft criteria and draft maps reasonably reflect the most IAL for each agricultural industry?
- If not, what criteria or areas mapped need to be changed?

Further questions can be developed to investigate other aspects of the project including resource and socio-economic information. For instance, a specific question on predicted climate changes or market changes may be relevant.

Follow on workshop

A follow on workshop with the working group assists the process of data collation and allows:

- feedback to the working group on the work undertaken in the first workshop
- time for convenors to collate and present the revised resource, socio-economic or agricultural industry criteria and thresholds and develop draft digital maps for the working group
- the opportunity for the working group to revisit, refine and amend draft criteria, thresholds and maps and provide more relevant information.

A summary of the responses to the workshop (including from worksheets) helps to inform the revision of the maps, the development of project reports and any AIPs. Summary information may include:

- key features of major agricultural industries for the study area
- the important requirements (resource and socio-economic) of agricultural industries selected
- economic information and statistics on agricultural production and employment
- current challenges (including climate impacts and market outlooks)
- land use implications and recommendations.

After the workshops

Refining and amending the draft criteria at the workshops is a critical step in the development of the final products. Sometimes further meetings with relevant experts and key stakeholders are required if agreement cannot be reached. For instance, in the pilot project, there were difficulties agreeing on the threshold criteria for lamb production at workshops. Extra meetings with key stakeholders and the former NSW DPI extension officers were held to discuss the appropriate thresholds for prime lamb production in greater detail.

In the pilot project the revised draft maps for each agricultural industry were also presented to former NSW DPI extension officers to verify that the location criteria and resultant maps identified the highly suitable (important) locations for the agricultural industries studied. This could be undertaken for any of the mapping approaches.

Nomenclature of mapping product

To assist with developing a consistent understanding of the approach and scale in identifying IAL within projects, specific nomenclature has been developed. Projects are undertaken at the local, sub-regional or regional scale and the following nomenclature is recommended.

Local (L)

Sub-regional (Sr)

Regional (R)

State (S)

To distinguish between the four types of projects, the following nomenclature is recommended.

Current land use (C)

Biophysical mapping (B)

Socio-economic mapping (S)

Agricultural industry mapping (AI)

Nomenclature for the approach is combined with the scale at which it is undertaken. For instance, if a project is undertaken at the sub-regional scale and the current land use approach is used, the nomenclature is SrC. If the project is undertaken at the local scale using the agricultural industry mapping approach, the nomenclature is LAI. If it is a regional scale project using the socio-economic approach, the nomenclature is RS etc.

7. Product development, application to strategic planning and planning policy and risk assessment

Product development and application to strategic planning and planning policy

The development of products for the project will depend on the strategic context, project purpose, scale, time frames and resources. Products can include:

- maps showing the extent of lands considered most suitable for selected resources, socio-economic factors and agricultural industries, with criteria and thresholds used to derive the maps. Extra information could include land use zones, local/regional infrastructure and growth corridor areas. Such information could provide a useful comparison of land identified as important for agriculture compared to land identified for strategic regional growth.
- a supporting report or profile document with critical information on high quality agricultural resources, current agricultural land uses, agricultural industry statistics, trends, economic conditions, productivity and business scale trends. This can include an analysis of relevant influencing factors for agricultural industries such as infrastructure (transport, saleyards, silos, abattoirs etc.), historic factors, climate variability and change, irrigation or water availability, market types and proximity. This information sets the context for the maps and assists in making key planning decisions. It also provides background material for any analysis of regional competitive advantages, opportunities, outlook and strategies for agricultural investment and land use planning strategies.
- other products such as a newsletter or other social media products to inform working group participants of the workshop outcomes and where further information such as a final report can be viewed.

Risk assessment

Consideration should also be given to the assessment of risk in representing results on the maps. A confidence map and metadata statement will provide information on the overall level of map accuracy and data sources used (see section 5). However, other limitations may also be evident and should be documented. This may include:

- a statement on the accuracy of the map products to make clear any limitations that may affect their use and interpretation. Questions such as: how concrete are the delineating lines on the map, is there significant differences either side of the line or is there a degree of similarity across lines that should be considered in their interpretation. It is useful, for instance, to include criteria and thresholds on maps
- analysis of the interplay between different approaches and how that may impact on map accuracy and interpretation. For instance, if the socio economic approach is overlain over the biophysical approach, then consideration should be given to the emphasis of those approaches on final map development. Those aspects require careful communication.
- maps produced with caveats so that any limitations can be clearly communicated.

8. More information

It is our aim to update and improve this guideline. We are always interested to hear from organisations that use this guideline and their experiences with its use, particularly for local and regional land use planning.

Please contact the NSW Department of Primary Industries by email at landuse.ag@dpi.nsw.gov.au.

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Appendixes

Appendix 1 Examples of agricultural mapping approaches

Current agricultural land use mapping

Sydney Basin mapping (nomenclature - CR)

This study was undertaken at the regional scale to identify current agricultural land uses in the Sydney Basin, NSW.

Purpose and strategic context

The former NSW DP&I engaged Gutteridge, Haskins and Davey to undertake a Sydney agricultural lands mapping project. The project mapped the amount and type of agricultural enterprises in the Sydney Basin, with a focus on intensive agricultural industries. With the limited scope to expand the footprint of agricultural land use in the basin, the project was intended to help LGAs retain land for agricultural production. (Docking pers comm 2012).

The outcomes of the project are informing strategic land use planning for Sydney to address increasing pressures of converting limited and productive agricultural land into urban land uses.

The dataset developed provides a valuable baseline to analyse land use change into the future and provides an important resource for a variety of stakeholders.

Area and scale

This project was undertaken at the regional level and included a large number of LGAs to enable the whole Sydney basin to be studied to provide input to the Sydney Metropolitan Strategy. It included 26 LGAs bounded by Wyong LGA in the north east, Hawkesbury LGA in the north west, Blue mountains LGA in the west, and Wollondilly and Sutherland LGAs in the south.

The scale of the dataset is 1:10,000. So despite the project being studied at the regional level, the dataset itself has been developed to provide relatively detailed information for local government use.

Products

The project produced a spatial land use dataset, a map of agricultural land uses and methodology that was able to be repeated over time. The dataset was produced by analysing remote sensing (SPOT5) information that was converted to tabular form to summarise the total areas by land use and LGA.

Application of the products

The project provides a snapshot of agricultural land uses as at 2011. It has the potential to be used for:

- property analysis by intersecting the data with cadastre to understand the number of holdings, farm sizes and types of land uses within the same property
- change detection analysis by undertaking a similar study at a future date to analyse land use changes and the implications for land use planning.

References

Gutteridge, Haskins and Davey, 2012. NSW Department of Planning and Infrastructure. Report for Sydney agricultural lands mapping. Final report. Unpublished.

Biophysical mapping

Biophysical strategic agricultural land mapping (nomenclature BS)

This study was undertaken at the state level to identify highly productive agricultural land with unique natural resource characteristics and socio-economic values.

Purpose and strategic context

The NSW Governments Strategic Regional Land Use Policy, released in September 2012 set out initiatives to better balance growth in the mining and coal seam gas (CSG) industries. The aim was to protect important agricultural industry land and water resources (NSW DP&I 2012). To help address the challenge of achieving balanced land use outcomes, mapping of strategic agricultural land (SAL) was undertaken using LSC maps, inherent soil fertility maps and availability of surface and groundwater information provided by the NSW Office of Environment and Heritage (NSW OEH) and NSW Office of Water using a rule set develop by NSW DPI and NSW OEH (Milford, 2016).

“Strategic agricultural land is highly productive land that has both unique natural resource characteristics (such as soil and water resources) as well as socio-economic value (such as high productivity, infrastructure availability and access to markets)” (Australian Government, 2016). Land that is mapped as SAL is then subject to extra protection from mining and CSG production proposals (NSW DP&I 2012).

“Biophysical strategic agricultural land is land with a rare combination of natural resources highly suitable for agriculture. These lands intrinsically have the best quality landforms, soil and water resources which are naturally capable of sustaining high levels of productivity and require minimal management practices to maintain this high quality” (NSW DP&I 2012). It focuses on identifying resources with exceptional agricultural value at the state level (typically of state, national or international significance).

There is a standard process for site-based assessment of BSAL as described in the *Interim Protocol for Site Verification and Mapping of Biophysical Strategic Agricultural Land* (NSW Government 2013).

High socio-economic value (such as high productivity, infrastructure availability and access to markets) was also identified and included within a critical industry cluster (CIC). A CIC is a localised concentration of interrelated productive industries based on an agricultural product that provides significant employment opportunities and contributes to the identity of the region.

Area and scale

Mapping for BSAL was undertaken at the regional level to provide information for broader planning processes, rather than for the individual property level. Consequently, processes were put in place by the NSW government to assist in the verification of whether a particular site includes land identified as BSAL. The scale of the mapped information is 1:250,000 based on the underpinning data sets.

Products

The BSAL was identified on a map of NSW.

The New England, North West and Upper Hunter Strategic Regional Plans were developed to minimise land use conflicts arising from the rapid growth of mining activities and the emergence of coal seam gas industry (NSW DP&I 2012). Those plans help to address the challenge of achieving balanced land use outcomes in the region. Areas with particularly high agricultural values were identified and mapped in consultation with key industry representatives and industry experts.

Application of the products

Information on BSAL informed the draft and final regional plans prepared by the NSW DPE. Land in the state with important biophysical agricultural resources has been used to assess mining and coal seam gas proposals.

References

NSW Planning and Environment, 2015. Safeguarding our agricultural land. http://www.planning.nsw.gov.au/Policy-and-Legislation/Mining-and-Resources/Safeguarding-our-Agricultural-Land

North Coast farmland mapping, 2005 and Mid North Coast farmland mapping, 2008 (nomenclature BR)

These studies are examples of regional scale projects to identify land with important biophysical attributes in the North Coast and Mid North Coast regions of NSW.

Purpose and strategic context

These projects were undertaken on the North Coast in 2005 and the Mid North Coast in 2008 by NSW government agencies.

The project aimed to protect land for a variety of agricultural industries that may be important now and into the future. Locations mapped as regionally significant farmland are identified in the Northern Rivers Regional Strategy as being unavailable for urban and rural residential development.

The project also aimed to protect significant farmland by identifying soil resource attributes that were of particular significance to the region or the state. It was intended to help local governments retain highly productive agricultural lands and provide greater certainty for agricultural investment. This could be principally achieved by strategic settlement planning to show areas where urban and rural residential development should not be targeted. This approach identified a broad range of lands that could provide resources for a range of important agricultural industries now and into the future, keeping land options open for new crops and farming methods. It distinguished between very high quality and unique agricultural soils/lands and other lands that were also important to agriculture but which were more extensive and less productive generally per unit area (NSW Department of Planning (NSW DoP) et al 2008 and NSW Department of Infrastructure, Planning and Natural Resources (NSW DIPNR) 2005).

Area and scale

The project was undertaken at a local level reflecting the study objective to identify land near developed areas on the coast under significant pressure from urbanisation. It included the two regions of the North Coast, including LGAs of Tweed, Byron, Kyogle, Lismore, Richmond Valley, and Ballina. The Mid North Coast project included the LGAs of Port Macquarie-Hastings, Kempsey, Nambucca, Bellingen, Coffs Harbour and Clarence Valley.

The farmland mapping studies used the soil landscape maps at a scale of 1:100,000 to provide information useful for broad level strategic mapping. This would not provide sufficient detail for planning at the property scale. Boundary verification would be required for this project if local governments in the region wished to review a boundary as part of a local growth management strategy. More recent and detailed datasets are now available from NSW OEH. See appendix 3 for more information on available datasets.

Products

The main product for the projects was the development of regionally significant agricultural land maps and reports on the final recommendations of the projects. The maps also considered land contiguity to rationalise important agricultural land shown in patches. Large contiguous areas of land mapped as the most important for current and/ or future food and fibre production are shown.

Planning principles were also developed to guide local government to implement farmland protection objectives, in conjunction with the maps. Those principles focused on how the maps could be used for different types of development, infrastructure and facilities and managing the urban-rural interface.

The section 117(2) (Ministerial Direction) of the *Environmental Planning and Assessment Act 1979* (EP&A Act) was issued to protect the significant farmland identified. This Ministerial Direction does not permit local government to rezone regionally significant farmland to urban or rural residential development.

The Ministerial Direction was intended to:

- ensure that the best agricultural land is available for current and future generations to grow food and fibre
- provide more certainty on the status of the best agricultural land, to assist local government with their local strategic settlement planning
- reduce land use conflict arising between agricultural land use and non-agricultural land use of farmland as caused by urban encroachment into farming areas.

Application of the products

The farmland mapping product has been used by LGAs in the regions to:

- provide guidance to LGAs undertaking their strategic land use planning so that important agricultural land is reflected within local strategic plans to inform the development of their LEPs
- provide farmland status on Section 149 certificates given to land purchasers to advise them of the agricultural importance of the land
- assess rezoning requests of regionally significant farmland proposed for conversion to urban or rural residential development using the s117(2) Ministerial Direction.

The availability of accurate soil landscape maps was the key data set to identify contiguous areas of important soil landscapes for agricultural industries that are highly dependent on soils. This data is not uniformly available outside coastal areas.

References

NSW Department of Infrastructure, Planning and Natural Resources and NSW Department of Primary Industries, 2005. Northern rivers farmland protection project. Final recommendations. http://www.planning.nsw.gov.au/Plans-for-your-area/Regional-Plans/North-Coast/~/media/6CF31FB885BF43669EFB7A5EB8D1DAEC.ashx

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Socio economic mapping

An example includes the production of economic ‘heat maps’, developed by coupling spatial land use data with ABS agricultural industry data. More detail is provided in the Central West/ Orana and Riverina/ Murray Regions mapping in the section on agricultural industry mapping below.

Agricultural industry mapping

Pilot project - important agricultural industry land mapping in the Central West and Upper Hunter of NSW (nomenclature IASr)

This study identified important agricultural industry land at the sub-regional scale in the Central West and Upper Hunter regions of NSW in 2012.

Purpose and strategic context

The pilot project was undertaken to develop and test a new methodology to identify and map IAL. The method was developed to inform strategic planning processes at the sub-regional scale to enable important food production lands to be zoned, retained and sustainably developed to meet the needs of current and future generations.

Important agricultural industry land was defined in the project as land that is highly suitable for specific agricultural industries in accordance with the typical biophysical, marketing and climatic conditions for the locality or region.

Area and scale

The pilot project was undertaken on a small sub-regional level across six LGAs divided into three sub regions including Blayney and Cabonne in the Central West of NSW, Forbes on the Western Slopes, and Singleton and Muswellbrook in the Upper Hunter. The study area intentionally included mountains, slopes and plains landscapes in three differing geographic areas of NSW to test the broad applicability of the methodology at the sub-regional level (Goodburn et al, 2012).

Products

While the initial focus was on mapping, the most important product was the development of a series of AIPs that provided a snapshot of each leading agricultural industry documenting the:

- important resources and spatial locations for each industry sector
- economic significance of agricultural industries
- likely impacts of climate variability and climate change
- major challenges faced
- scope for future industry growth (locally and/or regionally)
- critical infrastructure requirements and drivers for development
- important markets and the potential impacts of structural changes
- land use planning issues and recommendations.

The AIPs and supporting maps provide an overview of the nature and significance of each of the key agricultural industries (about the local, regional and state economy). They provide the context for planning decisions and assist with developing an understanding of the likely implications of those decisions as outlined below (NSW DPI, 2012).

Application of the products

Maps of specific agricultural industries were overlayed to identify the extent of lands considered important. The map and associated profiles can inform local government strategic land use planning, in particular the development of local environmental plans and accompanying strategies.

The report on the study undertaken by NSW DPI is *A Pilot Project to Map Important Agricultural Industry Lands in the Central West and Upper Hunter Regions of NSW* (NSW DPI 2012).

The application of the maps and AIPs has helped Cabonne Shire Council in its strategic planning and statutory planning functions. Examples of its use and possible improvements are outlined below.

- The information has enabled a more in depth understanding of specific agricultural industries, their extent and location to assist in assessing rezoning or development proposals. In particular, it has assisted with strategic planning, such as the potential impact of the future expansion of the City of Orange into agricultural land in the Cabonne Shire. It enabled a better understanding of land that can support a greater range of agricultural activities to be retained for agricultural purposes. It also identified land least suitable for agriculture for future city growth. The area north of Orange (Mullion Creek) for instance, would be the most reasonable trade off area to protect the highly productive basalt soils near Orange.
- Knowledge from the AIPs and mapped information provides insights into specialist or boutique farms (usually around 20ha) and the likelihood of their establishment or success. Garlic, corn and heritage potato farms with associated dwelling houses have been proposed. The AIPs provided sufficient background information for local government to assess the risk of converting land from agricultural land uses to non-agricultural (rural residential) purposes.
- The AIPs combine information on climate, hydrology and geology with the economic contribution of agricultural industries, industry challenges, climate change outlook, infrastructure requirements, development prospects and land use planning implications. It provides a more thorough understanding of an area's attributes. It is particularly useful as a communication tool for councillors who have a rural background and understand maps and information in the AIPs, rather than information on individual attributes that can be hard to interpret. Many council planners do not necessarily have a rural background and the information is useful as a snap shot of agricultural industries and their overall requirements. It can be a springboard to investigating further relevant information and drafting development consent conditions that are appropriate to that industry.
- The GIS mapping of agricultural industries describes the range of agricultural activity for specific locations of the LGAs. However, Cabonne Shire stated that it would also be useful to access the individual mapping criteria with the capability to overlay over the LGA map base. Local government zoning information from the relevant LEP overlain over the agricultural industry maps would also enable a comparison of IAL with land designated for future development.
- The agricultural industry maps and profiles helped to identify and communicate the local significance of the Mt Canobolas and the Canowindra River flats areas. The information highlighted the potential national significance of those areas that may assist in addressing future food security issues. The fact sheets highlighted the importance of the area for apple production, with only one other region in NSW having ideal conditions for apple production. The impacts of climate change may mean that the area will become even more important for apple production into the future.
- The agricultural industry maps and profiles are useful for planning roads for access to markets. They give a better picture of the commodities being transported and the transportation to enable peak traffic volumes to be predicted. This is also relevant for road, rail and air links into and out of the LGA. The information may also assist with planning for the integration of road and rail networks within the LGA and with other towns.

References

NSW Department of Primary Industries, 2012. Agricultural industry mapping: pilot mapping project. http://www.dpi.nsw.gov.au/land-and-water/land-use/lup/agriculture-industry-mapping/ag-mapping

IAL mapping in the Lower Hunter Region of NSW (nomenclature IASr)

This study is an example of a project undertaken at the sub-regional scale to identify IAL in the Lower Hunter Region of NSW.

Purpose and strategic context

The mapping project in the Lower Hunter region of NSW was undertaken as part of the Australian Government's (former Department of Sustainability, Environment, Water, Population and Communities) Sustainable Regional Development Program to protect matters of national environmental significance in selected high growth areas across Australia (Hunter Councils 2013). The project was completed in 2013. The Lower Hunter Region is a rapidly growing area and was a focus of the department's work.

The project was undertaken in two stages:

- Stage 1: Identifying key knowledge gaps and scientific research to inform sustainability planning for the Lower Hunter Region of NSW. That work also informed the review of the *NSW Lower Hunter Regional Strategy* and *Lower Hunter Regional Conservation Plan* (Hunter Councils 2013).
- Stage 2: undertaking a strategic assessment of proposed urban development and related infrastructure corridors (Hunter Councils 2013).

The Hunter and Central Coast Regional Environmental Management Strategy team at the Hunter Councils Inc. was commissioned to assess and map IAL in the Lower Hunter Region.

The Lower Hunter project was the first project after the pilot to map IAL. The project contributed significantly to the refinement of the methodology for mapping IAL. In particular it:

- clearly identified the significance of the dollar value contribution of agricultural industries and their likely location
- provided greater detail in defining location criteria and thresholds for a greater range of agricultural industries
- investigated planning implications of important agricultural industry locations by overlaying maps of land use zones and proposed future development areas for urban growth and infrastructure.

Area and scale

The Lower Hunter Mapping Project was also undertaken on a sub-regional level across five LGAs encompassing the entire Lower Hunter region of NSW including the Cessnock, Lake Macquarie, Maitland, Newcastle, and Port Stephens LGAs.

Products

The key outputs for the project included:

- sourcing, collating and analysing the best available agricultural data
- mapping the IAL utilising the same methodology as the pilot project
- organising and facilitating five structured workshops to engage stakeholders in each LGA
- preparing a final report with key findings and recommendations relating to potential threats and measures to protect agricultural industry lands. The findings are contained in

the report *Mapping Important Agricultural Lands in the Lower Hunter Region of NSW, June 2013* (Hunter Councils, 2013).

Application of the products

The study provides details on the extent of lands available for each industry and the extent of lands that may be impacted by future planning scenarios in the region.

Restrictions on land activity imposed by current and future planning regimes were also mapped (Hunter Councils 2013). This included land use planning zones in local environmental plans as well as permitted and prohibited agricultural land uses for each rural zone and areas allocated for future urban and industrial development in local government and state strategic plans. This enabled a subset of information to be mapped that identified important agricultural activities under the present planning regimes. Table 4 below outlines permitted and prohibited land uses for each agricultural industry in the context of strategic planning instruments for the Lower Hunter region.

Table 4: Permitted and prohibited land uses for each agricultural industry in the context of strategic planning instruments in the Lower Hunter region of NSW

Planning constraint parameters	**Important agricultural lands (IAL)**			**Other key agricultural industries**		
	Cultivated turf	**Broadacre crops**	**Viticulture**	**Beef cattle**	**Poultry**	**Protected crops**
Local environmental plan (LEP) zones for each LGA (see below for legend)	*Allowable in the following zones:* *CCC - RU2, RU4* *LMCC - RU2, RU4* *MCC - RU1, RU2* *NCC - E4 PSC RU1, RU2*	*Allowable in the following zones:* *CCC -RU2, RU3, RU4* *LMCC -RU2, RU3, RU4, RU6, E3, E4* *MCC - E2, E3, RU1, RU2* *NCC-E2, E3, E4,* *PSC - RU1, RU2*	*Allowable in the following zones:* *CCC - RU2, RU3, RU4* *LMCC - E3, RU2, RU4* *MCC- RU1, RU2* *NCC- E4* *PSC - RU1, RU2*	*Allowable in the following zones:* *CCC -RU2, RU3, RU4* *LMCC -RU2, RU3, RU4, RU6, E3, E4* *MCC - E2, E3, RU1, RU2* *NCC-E2, E3, E4* *PSC - RU1, RU2*	*Allowable in the following zones:* *CCC - RU2* *LMCC - RU2* *MCC - RU1* *NCC - NA* *PSC - RU1, RU2*	*Allowable in the following zones:* *CCC - RU2, RU4* *LMCC - RU2, RU3, RU4, RU6, E3, E4* *MCC - RU1, RU2* *NCC-E4* *PSC - RU1, RU2*
Future planning scenarios (as included in the Lower Hunter Regional Strategy (Department of Planning, 2006) & Council Settlement Strategies)	Agriculture is currently allowed, but future planning scenarios indicate land zoning changes that may restrict this land use.	Agriculture is currently allowed, but future planning scenarios indicate land zoning changes that may restrict this land use.	Agriculture is currently allowed, but future planning scenarios indicate land zoning changes that may restrict this land use.	Agriculture is currently allowed, but future planning scenarios indicate land zoning changes that may restrict this land use.	Agriculture is currently allowed, but future planning scenarios indicate land zoning changes that may restrict this land use.	Agriculture is currently allowed, but future planning scenarios indicate land zoning changes that may restrict this land use.
National parks	Excluded activity	Excluded activity	Excluded activity	Excluded activity	Excluded activity	Excluded activity
State forest	Excluded activity	Allowable with consent in CCC and LMCC	Allowable with consent in CCC	Allowable with consent in CCC and LMCC	Excluded activity	Allowable with consent in LMCC

(Hunter Councils 2013)

Legend:

CCC- Cessnock City Council
LMCC- Lake Macquarie City Council
MCC-Maitland City Council
NCC-Newcastle City Council
PSC-Port Stephens Council

Zones within relevant LEPs

RU1 Primary production
RU2 Rural landscape
RU3 Forestry
RU4 Primary production small lots
E3 Environmental management
E4 Environmental living

As the context of the study was a strategic, sub-regional assessment of agricultural lands, site specific planning controls, for instance, within local development control plans were not included in the constraints layers. The study acknowledged that the exclusion of the detailed planning controls would increase the mapped area available for productive agriculture.

Some of the key observations from the mapping project included:

- considering non-IAL for future growth, diversification and adaptation of the agricultural sector to enable it to respond to changing climate and market forces
- recognition of the importance of local and regional planning strategies in supporting agricultural industries to increase or maintain agricultural operations of a sufficient scale to remain economically viable, whilst also accommodating growth requirements.

A number of key recommendations were made by the Hunter Councils for consideration in the Australian Government's Strategic Assessment process and the NSW Government's regional planning process for the Lower Hunter and included:

- consideration of the Lower Hunter IAL mapping by relevant Australian, state, regional and local government planning instruments (including assessments of state and regionally significant developments) to seek to preserve this non-renewable resource for future generations
- identification and implementation of a strategic response to the proposed future planning scenarios and their impacts on the three LGAs (Maitland, Port Stephens and Cessnock). These three LGAs contain 93% of the identified IAL in the region and have the potential to reduce IAL by 17%
- further investigation of opportunities for protecting the more contiguous patches of IAL available in the western and northern sections of the region
- the historical settlement patterns and future development pressures occurring in the coastal LGA's of Lake Macquarie and Newcastle heighten the importance of these LGAs potential to facilitate buffering from encroachment, capitalise on the sustainability opportunities available through co-location of industries. There is also the potential to take advantage of carbon farming, bio banking, corridor maintenance and other biodiversity conservation opportunities.
- protection of other non-IAL lands available for agricultural activities (as depicted in the beef cattle industry maps) as they are considered important for the ongoing viability of agriculture in the region. This will ensure there are adequate lands available to allow the agricultural sector to continue to adapt to future economic pressures, market opportunities and climate change impacts.
- the continued accommodation of poultry farming and protected cropping industries that are dependent upon local planning regimes rather than access to important biophysical lands. These industries significantly contribute to the regional economy and have continued to expand over the last ten years. (Hunter Councils 2013). Table 5 documents the criteria and thresholds identified by the project.

Table 5. Criteria and thresholds for mapping important poultry industry lands in the Lower Hunter region of NSW

	Criteria	**Thresholds**
Biophysical	General landscape	Biosecurity limitations Proximity to neighbours Above 1 in 100 year flood level
	Land capability	Classes 3, 4, 5, 6
	Soil fertility	n/a
	Rainfall/ water access	Highly reliable water source
	Slope	< 6 degrees
	Temperature	n/a
	Acid sulphate soils	n/a
Planning	Zoning	RU1, RU2 RU4 (not in Lake Maquarie City Council) Buffer - (100m from waterways) - 3km to wetlands frequented by wild birds Above 1 in 100 year flood level
Industry	General	Effluent maintenance
	Support services	Experienced labour (24/7) Accessible processing plant Veterinary industry Feed suppliers
	Affiliated industries	Close association between: • Eggs and meat poultry for requirements (slaughter houses, poultry manure users, transport) • Livestock and crops (feed source) • Fruit and wine (tourism)
	Key marketing/ economic advantage	Reliable water and electricity supply Distance to processing plant (meat) Proximity to F3 freeway (to Sydney market) Branding (historic, scenic, location) Brand clusters
	Key regional infrastructure	Low transport costs Reliable water sources Reliable electricity/ gas for irrigation Independent farm advice
	On-farm investment and infrastructure	Sheds Industry training Irrigation Stock Specialised equipment Roads/ drainage Monitoring equipment (air and odour)

(Hunter Councils 2013)

Note: 1 in 100 year flood level refers to a flood level or peak that has a one in a hundred, or 1%, chance of being equalled or exceeded in any year.

References

Hunter Councils Environment Division, 2013. Mapping important agricultural land in the Lower Hunter region of NSW. https://www.environment.gov.au/system/files/pages/25570c73-a276-4efb-82f4-16f802320e62/files/hc-important-agricultural-lands.pdf

Central West/ Orana and Riverina/ Murray regions of NSW important agricultural land mapping (nomenclature BSIAR)

This study was undertaken at the large regional scale and used three mapping approaches in the Central West/ Orana and Riverina/ Murray regions of NSW. IAL, high quality biophysical lands, and important land identified by using socio-economic criteria were mapped.

Purpose and strategic context

The mapping project was undertaken in 2015 by NSW DPE to provide recommendations for the Central West/ Orana and Riverina/ Murray Regions Regional Plans.

The project studied the important agricultural industries, their land requirements and economic importance. It also identified high quality biophysical land and mapped socio-economic information to provide input to the strategic planning processes. Land use planning tools were also reviewed in Australia and overseas to provide planning policy recommendations to assist in maintaining the agricultural resource and encourage opportunities for agriculture and associated secondary industries.

Area and scale

This project was undertaken over a much larger area than any of the other projects in this appendix, reflecting the broader nature of agriculture in the regions. It included 20 LGAs from the Central West and Orana Region and 26 LGAs from the Riverina and Murray Region. The much larger area of this project necessitated agricultural industry representation over a broader area of land as well as greater distances for participants to travel to workshops.

Products

Key outputs for the project included:

- industry statistics and information using ABS and local information
- maps and reports on important regional agricultural land and industries – Table 6, describes the criteria and thresholds
- maps of high quality biophysical resources and maps of high productive value regardless of agricultural industries
- consultation with industry representatives and other stakeholders to determine industry characteristics and spatial extent and future opportunities
- profiles on the main industry sectors, including associated secondary and rural industry in the region, impacts of climate change and growth opportunities
- review of planning for agricultural lands including land use planning tools in Australia and internationally
- recommended planning policies that maintain the agriculture resource and encourage agriculture opportunities and associated secondary industries, including policies that should not be used.

The project examined the status and current trends relevant to the main agricultural industries within the subject region. It analysed available statistical data, regional and industry reports to identify the most important issues facing producers and their industries, the main drivers of change for those industries, including economic conditions, productivity and business scale trends (RMCG 2016).

It included an analysis of irrigation and transport, as two main determinants of the growth and supply in the region and considered climate change and its impacts on the main agricultural industries. Regional competitive advantages are also analysed with a summary of the opportunities for agriculture in the region and future outlook (RMCG 2016).

The point of difference with this project however, is the overlay of high quality biophysical resource information and the production of economic 'heat maps', developed by combining spatial land use data with ABS agricultural industry data. The latter was calculated by applying an agricultural industry multiplier to the regional agricultural industry gross value on a land unit basis. This represented the relationship between the initial increases in output from one agricultural industry to the increase in output of all agricultural industries. This showed that intensive industries, such as horticulture, generated greater value per unit of area relative to extensive industries, such as grazing. A threshold of greater than $100,000 was used to define regionally important agricultural industry land from an economic perspective (RMCG 2016).

Application of the products

The final report provides recommendations for input into the NSW DPE 2016 Regional Plans. The draft Central West and Orana Regional Plan in particular includes the following:

- Recognition of the importance of agribusiness to the regional and state economies and regional settlements
- The need for increased investment, innovation and diversification in the agribusiness sector to strengthen the economy, support jobs growth and overcome potential barriers to investment and industry diversification
- that the agricultural supply chain, including key freight network infrastructure i.e. grain silos, abattoirs, saleyards, secondary processing facilities and transport and logistics industries be protected in local plans
- Identification of investment opportunities in the supply chain infrastructure
- Identification of high quality biophysical and socio-economic important lands.

(NSW DPE 2015)

A key need was the requirement to upgrade freight, produce handling and transport infrastructure for agriculture to expand. Telecommunications and Internet infrastructure was also identified as requiring further upgrading to facilitate growth of agriculture and its associated processing industries (RMCG 2016).

In the future, more information on important agricultural industries will be gathered and mapped at the local planning level to address the implications of the applicability of broad scale regional mapping to the local level.

Table 6 outlines location criteria and thresholds for each agricultural industry developed with relevant stakeholders for the Central West and Orana Mapping Project, 2015.

Table 6. Criteria and thresholds used for mapping important agricultural lands in the Central West and Orana regions of NSW

	Annual Horticulture	Perennial Horticulture	Meat/ Coarse wool	Fine wool	Cropping	Cotton
Rural land capability classes	2, 3, 4	2, 3, 4	2, 3, 4, 5	4, 5	2, 3, 4	2, 3,4
Slope (%)	≤10	≤10	≤20	≤30	≤20	≤10
Rainfall (mm)	N/A	N/A	500 to 1000	>600	>400	N/A
Irrigation	Yes	Yes	Yes	No	Yes	Yes
Elevation (m)	>500	>500	N/A	N/A	N/A	N/A
Other	N/A	East of Newell Hwy	N/A	N/A	N/A	West of Newell Hwy

Note: Agricultural industries can potentially be undertaken over a range of thresholds for land capability and soil fertility. For instance, meat/ coarse wool are undertaken from very high to moderately low land capability.

References/ further information

RMCG, 2016. Central West Orana Agricultural Industries Final Report, January 2016. Department of Planning and Environment. http://www.planning.nsw.gov.au/en/Plans-for-Your-Area/Regional-Plans/Central-West-and-Orana/~/media/29D63C6B92D0422986DD58531F383722.ashx

RMCG, 2016. Riverina Murray Agricultural Industries Final Report, January 2016. Department of Planning and Environment. http://www.planning.nsw.gov.au/Plans-for-Your-Area/Regional-Plans/Riverina-Murray/~/media/E170FEF15B7E41E6821C995058C4EE57.ashx

Appendix 2 A review of the NSW DPI pilot mapping project

Associate Professor Bill Pritchard from the University of Sydney undertook a formal review of the pilot project. The review suggested the following changes to the methodology.

Recommendations from the review

- The technical assumptions and program design are sound. The pilot project makes an important contribution to the ongoing development of evidence-based strategic planning in NSW.
- There is benefit in integrating the process developed through the pilot project into the Government's broader Strategic Regional Land Use policy. The expertise developed through the pilot project would be helpful for the NSW Government in strategic land use planning.
- Any future rollout of the pilot project should consider using alternative geographical units such as catchments or natural resource regions. This could be used concurrently with analysis based around the local government scale.
- Attention needs to be given to more transparent presentation of the assumptions that underlie determination of IAL. The current presentation of maps on the NSW DPI website is suitable for the pilot project, but would be inadequate for broader use.
- Maps of important agricultural land for each agricultural industry should be compared against maps of actual land used for each agricultural industry. These maps would be useful for many users.
- The range of biophysical indicators used in the pilot maps is appropriate given the constraints of data and state wide extent of the project. In future years, data sources used in the pilot project should be revised to ensure the most accurate and appropriate sources are utilised.
- Consideration should be given to the potential inclusion of four sets of socio-economic data in the pilot project (i) average rural land values per hectare; (ii) average property size; (iii) zoning and minimum lot size regulations, (iv) critical industry infrastructure.
- The goal of the pilot project should be to provide a clearly defined set of biophysical and socio-economic indicators representing agricultural industry data with application to a broad range of stakeholders, including NSW government agencies. It would be ideal to provide data at a smaller scale so maps can be used for zoning decisions, development proposals and, in western parts of the state, land use planning at the individual property scale
- It is particularly important to clearly define what the mapped information displays. There should be a definition of what is actually being mapped as well as a definition for each of the criteria used. An example of a definition of what is being mapped is outlined below.

> Interpreting the maps
>
> The maps display the area of land considered as comprising the optimal biophysical (and socio-economic conditions in each LGA for the particular agricultural industry in question. This may or may not coincide with the area of land in the LGA currently used by that agricultural industry. What the maps display, therefore, is the hypothetical *most suitable extent* of the agricultural industries at the local government level, given assumptions that are made about the biophysical and human environment.

- The utility of agricultural land mapping is conditional to the time in which it occurred. Maintaining data relevancy for the pilot project is important and it would be ideal to reconvene stakeholder reference groups every few years or as new data becomes available.
- One of the key outputs from this stage is to develop a clear statement of the boundary conditions that have been set to define each indicator.

(Pritchard 2013)

Other recommendations from the review of the NSW DPI pilot mapping project, 2012 and the Lower Hunter Mapping Project, 2013.

Contiguity of land identified and zoned for agricultural industries is an important consideration in planning for agricultural industry lands.

- It is preferable to have large continuous areas of land identified as suitable for agricultural activities. Large areas of land will also more likely support future growth and adaptation of agricultural industries, enabling them to respond to changing climates and market forces and less likely to result in land use conflicts. Those contiguous areas of land suitable for agricultural industry activities also have the potential to facilitate buffering from encroachment of non-compatible land uses, capitalise on sustainability opportunities available through the co-location of industries, and may increase the ability to take advantage of carbon farming, bio-banking and other similar opportunities.
- Where there are lands identified as important for agriculture in patches with other non-compatible land uses in between, there will need to be some realistic rationalisation as to whether an agricultural industry can operate in the long term given the constraints that may be imposed in that situation.

Appendix 3 Notes on available data sets.

ABS statistics

The ABS statistical information includes:

- The Australian Bureau of Statistics (ABS) population census provides information on population and employment data for major agricultural industry groupings for each LGA (ABS 2016). That statistical information enables agricultural industry profiles to be developed. The census is undertaken every 5 years.
- The ABS Agricultural Census is undertaken every 5 years to provide the basic source of Australian agriculture commodity statistics (ABS 2016). The census is designed primarily to collect data about commodities (including area and production for crops, number of livestock and area irrigated). Data are also available on the number of producers for each commodity, and on the counts of producers by ANZSIC class (ABS 2016).

  This commodity data is used to produce data on the Value of Agricultural Commodities Produced (VACP). Information on inputs to the production process (water, fertilisers) is also collected and disseminated. Data are available at Statistical Division (SD) and Statistical Local Area (SLA). Data are available by Estimated Value of Agricultural Operations (EVAO), Australian and New Zealand Standard Industrial Classification (ANZSIC), commodity and specified size ranges (e.g. herd size). A number of supplementary collections are run in conjunction with the Agricultural Census, including Beekeeping (ABS funded), Apples and Pears (user funded) and Vineyards (user funded). Those supplementary surveys vary from year to year (ABS 2016).
- The ABS Rural Environment and Agricultural Commodity Survey (REACS) is conducted annually in the years between the five-yearly agricultural census (ABS 2014). Included are statistics on land use, crop and horticultural area and production, livestock numbers, farm management and demographic information. Prior to 2012–13, the ABS conducted an Agricultural Resource Management Survey (ARMS) and an Agricultural Commodity Survey (ACS) in alternating years. In 2012–13, the ARMS and ACS were combined to form the REACS.

Various inherent and critical limitations apply to ABS agricultural statistics when using and interpreting the reported values. They are listed below:

- The resultant ‘value of agricultural production’ figures indicate the relative importance of agricultural sectors, but do not show the actual total value of agricultural production.
- ABS identifies an ‘estimated value of agricultural production’ by multiplying the estimated quantity of each commodity type as recorded in the agricultural census by the average unit value of tat commodity (farm gate values for unprocessed commodities). The figures do not show the actual value the farmer received for particular products (for example by selling directly or value adding) or the retail value of food and fibre products. Nor does it show the flow-on contribution of agriculture to the broader economy (for example, food processing or manufacturing industries). It also excludes any values for equine industries.
- Census employment data does not pick up most of agriculture’s seasonal employment.

Despite these limitations, the ABS agricultural data provides the most consistent and extensive and comparable information on agricultural production value and employment data across NSW. ABS data should be considered in combination with other studies or alternative sources of locally relevant data.

Extra (ABS) explanatory notes in relation to the use of ABS data in the pilot project:

- Data was gathered from a range of sources to address ABS limitations. Industry studies and statistics as well as marketing authority information was sourced. Local industry experts were a useful source of statistical and other relevant industry information.
- An estimate of the overall contribution of agriculture to the NSW economy, as presented in the AIPs in the pilot project was obtained by multiplying the wholesale value of agriculture by the standard ABS multiplier for agriculture production, which is 2.178 (NSW Trade and Investment 2015). An indication of the overall contribution of agricultural jobs to NSW employment was similarly obtained by multiplying employment in a particular agricultural industry by the standard ABS multiplier for agricultural employment, which is 1.828.
- Statistics on perennial crops and livestock relate to the position as at 30 June 2011 and the production during the year ended on that date, or fruit set by that date. Statistics for apples, pears and grapes that are harvested after 30 June are collected by supplementary collections and included in the ABS publication (ABS 2014).

NSW DPI website statistics

The NSW DPI has prepared a number of spread sheets to summarise ABS information on the agricultural land use planning website (NSW DPI 2016). Information includes:

- Agricultural production data - interactive spread sheets produced by NSW DPI can be used to compare agricultural production between Local Government Areas and a Statistical Division (SD) or NSW. These values are represented as a dollar value and as a percentage and are presented in both a table and a graph format. Data from the 2006 and 2011 census is captured within these spread sheets. The spread sheets also include some summary data of the number of stock, hectares of produce, area of holdings and number of people employed in the agriculture industry. This can be useful when determining socio-economic trends for a particular area.
- Agricultural commodity profile reports from the 2006 census have been prepared for the Sydney region and NSW that document the trends across LGAs and regional statistical divisions for major agricultural commodities. The reports provide a clear summary of the size, value and distribution of the main agricultural commodities in NSW. Commodity maps for NSW provide a visual representation of gross annual revenue trends across each LGA. Comparing agricultural production between various LGAs and regions is useful in identifying regionally or state significant industries.
- Employment locations in agriculture, forestry and fisheries - these maps are based on the ABS 2006 place of work (POW) data. The address of each employed person's main place of work, in the week prior to census night, is used to code to a destination zone. Destination zones are designed by state and territory transport authorities (STAs) that use this data to analyse transport patterns assist in planning for transport systems. The employment density maps show where full-time employment in the agriculture, fisheries or forestry industries occurs in NSW and Sydney.

CSIRO statistics

CSIRO have produced TraNSIT to analyse both small and large scale investments in the agriculture supply chain, with current applications covering almost all Australian agricultural logistics. The model applies to livestock, agricultural crops and horticultural produce looking at the logistics from the paddock to the plate. More information is available at: http://www.csiro.au/en/Research/LWF/Areas/Landscape-management/Livestock-logistics/TRANSIT (CSIRO 2016).

Average annual rainfall

Australian Rainman developed by the Rural Industries Research and Development Corporation (RIRDC) provides world-wide data on monthly rainfall (9500 locations), an Australian data set of daily historical rainfall (3800 locations), long-term monthly temperatures (625 locations) and time series data of observed and modelled monthly/daily streamflow (400 locations) (RIRDC 2005).

The ANUCLIM Version 6.1 software package enables information on monthly, seasonal and annual mean climate variables to be supplied (Xu and Hutchinson 2011). The ANUCLIM also generates growth indices for modelling the growth of crops and plants and enables climate change scenarios to be applied (Xu and Hutchinson 2011).

Rural land capability and agricultural land classification maps

The RLC and ALC maps are two major rural land mapping programs that were undertaken in the 1980s and 1990s.

The eight class RLC mapping system developed by the former NSW Soil Conservation Service classified land in terms of its inherent physical capacity of land to sustain a range of land uses, and identified management measures needed to protect the land from soil erosion and other forms of land degradation (Cunningham et al. 1988). The classification focused on soil characteristics and erosion/degradation risks. A decline in resources affecting agricultural productivity, infrastructure functionality and natural ecosystem values could be expected if land was not managed in accordance with its capability risks.

The agricultural potential of a site (its agricultural suitability) was also identified to help LGAs identify the more productive lands for agricultural uses to plan for their retention. This led to the five-class ALC mapping system developed by the former NSW Department of Agriculture (Hulme et al. 2002).

ALC maps identified lands best suited to crop and pasture production on the basis of known physical resources (such as land capability, aspect and the availability of water) and socio-economic factors (including closeness to markets or processing facilities, the scale of similar contiguous lands, available technology and farm development costs). The methodology is documented in the Rural Lands Evaluation Manual (NSW DoP 1988), but was subsequently varied as new technologies became available. The last maps of this type were made in 1999.

RLC and ALC mapping systems were each mapped at a broad scale (often 1:100,000) using the limited available data sets and technologies that predated widespread use of GIS systems. They were also predominantly mapped on a campaign basis using multiple teams and variable base data. The maps typically have inherent flaws and variations that create information mismatches when attempting to digitally join or compare maps.

ALC maps cover NSW incompletely and in some instances only cover part of an LGA. Also, since the last of these maps were made, landscapes in many regions have significantly changed through urban expansion, industrial and mining developments, vegetation regrowth, soil degradation and clearing of native vegetation, with accompanying changes in economic and environmental values. The amount of high quality land available for agriculture is significantly different from that indicated in the earlier maps.

NSW land and soil capability maps

The NSW LSC scheme builds on the RLC system developed in 1986. It retains the eight classes of the earlier system but places more emphasis on specific soil limitations and their management (NSW OEH 2012).

The LSC assessment scheme uses the biophysical features of the land and soil to derive detailed rating tables for a range of land and soil hazards. Each hazard is given a rating between 1 (best, highest capability land) and 8 (worst, lowest capability land), and the final LSC class of the land is based on the most limiting hazard. Most of the eastern and central NSW has been

mapped at a scale of 1:100,000, with the rest of NSW undertaken at the 1:250,000 (NSW OEH 2012).

The LSC assessment scheme was first applied at a broad scale in 2008 to support implementation of the monitoring, evaluation and reporting strategy. The derived LSC map for NSW was used, with some revision, by the NSW Department of Primary Industries to assist in the determination of BSAL as a component of the NSW Government's strategic regional land use plans." (NSW OEH 2016)

Preliminary LSC data was also an important information resource for the pilot project and for the identification of IAL for regional strategic land use planning.

Land systems maps

This broad scale mapping of the Western Division of NSW was carried out in the mid-1980s to delineate areas or groups of areas with recurring patterns of topography, soils and vegetation. The maps and associated report cover the entire division at the 1:250,000 scale, and are available as digital map data plus an associated report" (NSW OEH 2016).

Derived inherent soil fertility maps

This map identifies the estimation of inherent soil fertility of dominant soil types in NSW. "It uses the best available soils and natural resource mapping developed for the LSC dataset" (NSW OEH 2013).

A map of inherent soil fertility was derived from a lookup table system linking a fertility class to a particular soil type (great soils group), which was then attributed for each soil map unit" (NSW OEH 2013)

A five-class system is used to describe soil fertility on maps in NSW. The five-class system includes:

Low (1)
Moderately low (2)
Moderate (3)
Moderately high (4)
High (5)

The derived inherent soil fertility map is the primary dataset used to create the regional BSAL maps under the NSW Government's Strategic Regional Land Use Policy, published 2013. It is the only state wide spatial data set indicating soil fertility that can be consistently applied across various regions in NSW (NSW OEH 2013).

Soil fertility was considered critical for identifying the most highly productive lands for those agricultural industries that are highly dependent on soil resources, such as cropping and grazing.

Soil and landscape grid of Australia

The Terrestrial Ecosystem Research Network (TERN) has delivered the soil and landscape grid of Australia. That dataset is nationally consistent and comprehensive soil and landscape attribute data at a fine resolution (TERN 2009). The soil and landscape grid (grid) draws together historical data together with new data generated from sampling, laboratory sensing, modelling and remote sensing. It is a collaborative effort between the CSIRO, the University of Sydney, Geoscience Australia and federal, state and territory agencies (TERN 2009).

The grid provides data on soil and landscape attributes. Estimates of uncertainty are provided. Data is available for six soil depths down to a maximum of 2 meters (0-5cm, 5-15cm, 15-30cm, 30-60cm, 60-100cm, 100-200cm) and provided at 90m pixels (TERN 2009).

Soil attributes available are:

- Bulk density
- Organic carbon
- Clay
- Silt
- Sand
- pH (water)
- pH (CaCl2)
- Available water capacity
- Total Nitrogen
- Total Phosphorus
- Effective cation exchange capacity
- Depth of regolith
- Depth of soil
- Coarse fragments

Landscape attributes available are:

- Slope (%)
- Slope (%) median 200m radius
- Slope relief classification
- Aspect
- Relief 1000m radius
- Relief 300m radius
- Topographic wetness index
- Topographic position index
- Partial contributing area
- Multi-resolution valley bottom flatness (MrVBF)
- Plan curvature
- Profile curvature
- Prescott Index
- Solar radiation (SRAD) net radiation January
- SRAD net radiation July
- SRAD total shortwave sloping surface January
- SRAD total shortwave sloping surface July

(TERN 2009)

Topographic data

Elevation models derived from the Shuttle Radar Topography Mission 2000 (SRTM) data are routinely used in geographic information systems to identify altitude, slopes and terrain. The SRTM is an international research effort that obtained digital elevation models on a near-global scale to generate the most complete high-resolution digital topographic database of earth prior to the release of the ASTER GDEM in 2009. The SRTM consisted of a specially modified radar system that flew on board the Space Shuttle Endeavour during the 11-day STS-99 mission in February 2000 (Geosciences Australia 2010).

Current digital topographic information is at 30m resolution, which is nearly 10 times finer than previous Australian digital elevation models, providing much greater detail. A 90 m resolution is also provided (Geosciences Australia 2010).

Data on altitude (elevation) was used to indicate climatic and seasonal production constraints (e.g. due to frost severity and frequency, chill periods and fruit setting). This helped to identify important lands for horticultural and fine wool grazing enterprises in the Central West of NSW. This information was not relevant to the Upper Hunter agricultural production because higher

elevations are not used for agriculture (private timbered lands, state forests or conservation reserves).

Slope is an important factor for agricultural enterprises as it constrains vehicle movements, irrigation efficiency and increased risk of erosion. Slope is part of the LSC mapping and this source was adequate for the agricultural industries mapped in the Central West, NSW.

Geological mapping

The Geological Survey of NSW produces geological maps that identify the character and distribution of rock units at or near the Earth's surface.

The geology of the surface and near surface of the earth influences greatly the landforms and soils critical for sustainable types of agriculture (Department of Industry, Resources and Energy, 2016).

Geological information was used where there was a direct relationship to soils indicative of specific agricultural industries.

Land use maps

NSW mapping

A data set of land use between June 2000 and June 2007 for NSW land use is classified to three separate classification schemes:

- NSW Land Use Mapping Program (LUMAP)
- NSW Standard Classification for Attributes of Land (SCALD)
- NSW Australian Land Use and Management (ALUM) classification.

The most recent classification for mapping land use classes in NSW is LUMAP undertaken by NSW OEH. This classification is simple and numeric and is also open-ended to enable extra classes to be added (NSW OEH 2010).

NSW SCALD classification was the standard for mapping land use in NSW and was developed before LUMAP. It is a combined alphanumeric classification system (NSW OEH 2010).

The ALUM classification is based upon the modified Baxter & Russell classification. Mapping commenced in April 2001 and was completed in June 2007. The data set is dated at the time of the land use when the satellite imagery was acquired, which ranges from 1999 to 2006. This dataset was updated in May 2011 to include values in the vacant attribute fields of source, source date, source scale, reliability and LUMAP date (NSW OEH 2010).

National land use mapping

The ALUM classification system is a nationally consistent method to collect and present land use information for a wide range of users across Australia. The latest version (Version 8) conforms to the Australian Spatial Data Infrastructure standard for land use datasets.

Land use summaries have been put together for natural resource management regions, states and Australia based on catchment scale land use data available in March 2015. These reports include land use area statistics and a map for each region.

Land use mapping in Australia is conducted broadly at two scales: national scale and catchment scale (see Figure 1). Both land use mapping methods use the NSW ALUM classification system.

Technical information to support land use mapping in Australia has been developed by Australian and state government members of the Australian Collaborative Land Use and Management Program.

Land use mapping procedures are outlined in the *Guidelines for land use mapping in Australia: principles, procedures and definitions*, 4th edition and the *Addendum to the Guidelines for land use mapping in Australia: principles, procedures and definitions*, 4th Edition (ABARES 2011).

The handbook is the primary reference for the ALUM classification and outlines procedures and specifications for national scale and catchment scale land use mapping in Australia. The fourth edition of this handbook is the primary reference for Version 7 of the ALUM classification.

Recommended specifications for land use datasets provide for attribution of the prime land use (represented by the ALUM code), multiple land use, and source information (scale, date, and reliability). Specifications also address data formatting, spatial referencing, data resolution, spatial precision and attribute accuracy. An overall attribute accuracy of greater than 80 per cent is the benchmark standard.

The addendum provides guidance on the implementation of mapping principles and procedures outlined in the *Guidelines for land use mapping in Australia: principles, procedures and definitions*, 4th edition. The aim is to ensure that catchment scale mapping is relevant, up to date and reliable for decision-making. It focuses on the goals of catchment scale land use mapping, the potential to update land use mapping using ancillary information, and methods to improve the reliability of and confidence in catchment scale land use mapping" (ABARES 2016).

It should be noted that with any of the above land use mapping data sets, land use is current at the time of mapping. Land in rotation, such as cropping and grazing, may change seasonally and may not represent a broader shift in land use.

Soil landscape maps

The former NSW Soil Conservation Service and NSW Department of Land and Water produced soil landscape maps in the 1990s and 2000s. This mapping identifies soil landscape units based on identified unique combinations of soil types, landform and geology information. It identifies the relationships between soil properties and their distribution on the landscape. The reports that accompany the maps also provide descriptions of vegetation, land uses, land degradation and rural and urban capability for each landscape type.

Published soil landscape maps and reports focused on the coastal areas of NSW and are of variable scale, published at 1:100,000 or 1:250,000 (NSW OEH, 2016). The information is being continually updated and the NSW OEH has recent mapping data.

Relying on soil landscape maps as a key determinant of productive lands may be limiting for mapping in the western regions of NSW. The data may be useful for providing contextual information.

Ground water and surface water data

In any assessment and study of agricultural land use, the legislative and policy framework should be considered. The Water Management Act 2000 (NSW) (WMA) and the Water Act 1912 (NSW) (WA) provide the legislative basis for water use, management and planning in NSW. The WMA has largely replaced the planning and management frameworks in the WA (Department of Prime Minister and Cabinet (DPC 2006).

The WMA also effectively separates land rights from water rights, enabling the legal entitlement to access water resources within a catchment to be traded on the open market. Water trading options and caps (restrictions on the volume of water that can be extracted from particular water catchments) means that physical proximity to a source of water does not ensure that a land owner has an automatic legal right to access groundwater resources beneath the land, nor the surface water in adjoining creeks for irrigation (DPC 2006) .

The rules that govern water extraction, use and trading are included within the water sharing plans (WSPs). Licensing provisions under the WA remain in place where WSPs have not been developed. Rivers that are regulated (with the exception of rivers on the Queensland (Qsld)/ NSW border), some unregulated rivers and coastal groundwater aquifers are now subject to WSPs. Temporary and permanent trade occurs under WA provisions. Temporary trade is undertaken along the Qsld/NSW border rivers and smaller regulated rivers and inland alluvial aquifers not yet subject to a commenced water sharing plan (DPC 2006).

Regulated rivers are those where flows are supplemented by large state-owned water storages. The extent of the water storage and the reach of the stream(s) supplied are gazetted and licensed water users have defined water rights that may also refer to reliability of supply. Unregulated rivers are all other permanently flowing surface water streams and non-permanent streams of third order and above. Water licences may be held on these rivers but trading will generally be more constrained.

Proximity to regulated surface water sources and to alluviums (alluvial soils that contain mapped groundwater sources) can be important for grazing enterprises. Under the WMA, landholders and native title holders with direct frontage to surface water flows, and those whose land overlies groundwater aquifers, are permitted to extract water for livestock and domestic purposes (personal, domestic and non-commercial in the case of native title holders). This landholder entitlement can't be traded separately from the land title, hence spatial data showing proximity to regulated streams and to alluviums can be used to define important lands for grazing enterprises (DPC 2006).

The NSW Office of Water monitors groundwater levels and quality within defined aquifers (or groundwater sources) through a state wide network of thousands of groundwater observation bores. This digital point data does not readily identify the quality or reliability of those water sources. The NSW Office of Water also has spatial data on surface waters (such as rivers and creeks) and current licences and pumping points.

Property valuation data

The Valuer General of NSW provides information on the valuation of land in accordance with the *Valuation of Land Act 2001*. The Act also provides a land information data set with available property valuations.

The assumption made was that the greater the value of land per hectare, the greater the productivity of the land. Data provided from the Valuer General for the dollar value of land per hectare for the pilot project showed that there was some relationship between dollar value and productivity, but proximity to a regional urban centre raised the land's dollar value above its productive value. Consequently, the data was not a reliable determinant of productivity for all areas of the pilot study but was used to provide contextual information.

Spatial guideline

NSW DPI is currently developing a spatial guideline that outlines the strengths and weaknesses of the different types of agricultural mapping in NSW. The *Agricultural spatial resources guideline* is available on the NSW DPI Agricultural land use planning website (http://www.dpi.nsw.gov.au/land-and-water/land-use) (Squires 2017).

Note: NSW EOH data relevant to mapping IAL is publicly available from the NSW OEH data portal (NSW OEH 2016). Most of the soil and land information is accessible through eSPADE v2.0 (NSW OEH 2016).