2018 Northern Tablelands Local Land Services

Schools Property Planning Competition

Competition Manual

Glen Innes Agricultural Research and Advisory Station
Published by Local Land Services.

Schools Property Planning Competition 2018.

This document has been prepared by Michelle McKemey of Melaleuca Enterprises Environmental Consultancy Services with support from staff of the Glen Innes Agricultural Research and Advisory Station and Kim Deans, Ivan Lackay, Beth Brown, Jeff Lowien and various staff members of Northern Tablelands Local Land Services.

Photographs provided by Michelle McKemey or Northern Tablelands Local Land Services unless acknowledged otherwise.

The organisers would like to gratefully acknowledge the sponsorship and support of Regional Development Australia - Northern Inland NSW and the University of New England.

www.lls.nsw.gov.au

© State of New South Wales through Local Land Services, 2018.

Disclaimer: The information contained in this publication is based on knowledge and understanding at the time of writing (March 2018). Information included in this manual may be fictitious to be used only as part of the competition. Due to 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 Local Land Services or the user's independent adviser.
TABLE OF CONTENTS

1.1 Timetable for 2018 5
1.2 Tutorials 5
1.3 Syllabus Links 5
1.4 Getting Started 5

2. GLEN INNES AGRICULTURAL RESEARCH AND ADVISORY STATION FARM CASE STUDY 7
2.1 The Task 7
2.2 What is a Property Plan? 7
2.3 The Property Planning Process 7
2.4 Your Property Planning Competition Task 7
2.5 Report Requirements 9

3. PROPERTY INFORMATION – GLEN INNES AGRICULTURAL RESEARCH AND ADVISORY STATION 10
3.1 About Glen Innes Agricultural Research and Advisory Station 10
3.2 Landholder’s Aims 14
3.3 Maps 14

4. STOCKTAKE OF RESOURCES 15
4.1 Climate 15
4.2 Contours and Drainage 17
4.3 Infrastructure 17
4.4 Vegetation 18
4.5 Biodiversity 21
4.6 Land Capability 23
4.7 Land Management and Erosion Risk 25
4.8 Soils 25
4.9 Water Quality 27
4.10 Salinity 31

5. BIOSECURITY 33
5.1 What is Biosecurity? 33
5.2 Farm Biosecurity 33
5.3 Priority Areas for Farm Biosecurity 33
5.4 Livestock Diseases 33
5.5 Toxins and Chemical Residues 34
5.6 Pest Animals 34
5.7 Weeds 36
5.8 Emergency Issues 36
5.9 Key Points 36
6. **CULTURAL HERITAGE**

6.1 Aboriginal Cultural Heritage 37
6.2 Preserving Aboriginal Cultural Heritage on Private Property 38

7. **FARM BUSINESS PLANNING** 39

7.1 Farm Business Enterprises 39
7.2 Financial Information for Farm Decision Making 39
7.3 Glen Innes Agricultural Research and Advisory Station Current Enterprises 40
7.4 Pasture Management 41

8. **DEVELOPING THE FARM PLAN** 44

8.1 Land Use Hazards 44
8.2 Rainfall Use Efficiency 44
8.3 Legal Obligations 47
8.4 Making Decisions on Land Use 48
8.5 Monitoring 49
8.6 The Plan and Report 50

9. **FURTHER RESOURCES** 55

9.1 Expertise 55
9.2 Funding Opportunities 55
9.3 Other Relevant Organisations and Websites 55

10. **REFERENCES & FURTHER INFORMATION** 56

11. **GLOSSARY** 58

12. **APPENDIX 1 – MAPS** 60

12.1 Map 1 ‘Glen Innes Agricultural Research and Advisory Station Infrastructure’ 60
12.2 Map 2 ‘Glen Innes Agricultural Research and Advisory Station Rural Land Capability’ 61
12.3 Map 3 ‘Glen Innes Agricultural Research and Advisory Station Biodiversity’ 62
12.4 Map 4 ‘Glen Innes Agricultural Research and Advisory Station - Student Map’ 63

13. **APPENDIX 2 - VEGETATION SPECIES LIST** 64

14. **APPENDIX 3 - FAUNA SPECIES LIST** 65

15. **APPENDIX 4: MARKING SCHEDULE** 66

16. **APPENDIX 5: COVER PAGE TEMPLATE** 68

Introduction for Teachers
1.1 Timetable for 2018

<table>
<thead>
<tr>
<th>Date</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>Friday 6 April</td>
<td>Closing date for school registrations to attend the field day. Resources will be available online: <a href="http://northerntablelands.lls.nsw.gov.au/resource-hub/training/schools-property-planning-competition">northerntablelands.lls.nsw.gov.au/resource-hub/training/schools-property-planning-competition</a></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>May</td>
<td>Tutorials available in schools around the region</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Friday 15 June</td>
<td>The two best entries per class due for marking.</td>
</tr>
<tr>
<td></td>
<td>Post to: Kim Deans, Northern Tablelands LLS, PO Box 411, Inverell NSW 2360</td>
</tr>
</tbody>
</table>

The Schools Property Planning Competition is designed to give students an opportunity to study a local rural property in detail. The students are required to prepare a plan that provides for long term profitability as well as sustaining the natural resources of the area. The exercise draws together a number of land management themes and gives students the chance to apply their skills and knowledge to a real-life situation. The field day on Wednesday 2 May will provide an opportunity for students to participate in a range of activities and to engage with relevant government and industry experts.

1.2 Tutorials

After the field day, Northern Tablelands Local Land Services staff will be available to run tutorials at schools who are participating. The aim of the tutorials is to help students learn and produce the best property plan they can. Teachers can contact Kim Deans via email kim.deans@lls.nsw.gov.au or phone 0448 182183 to organise a tutorial for their school.

1.3 Syllabus Links

The Schools Property Planning Competition has been designed to address numerous outcomes of TAFE Agriculture courses, the School Certificate and HSC Agriculture syllabus, particularly the Farm Case Study unit. Links can also be made to the HSC Geography syllabus and the VET Primary Industries curriculum. Because the activity has been structured to accommodate students studying a range of subjects and abilities, teachers will need to determine the depth of study undertaken. A marking schedule is provided in Appendix 4, which will be used to judge entries submitted.

1.4 Getting Started

Each student and/or group (maximum of four per group) should be given a copy of all the relevant resources. In addition, students should access other resources from libraries, government departments or the internet.
To participate in the Schools Property Planning Competition you need to:

- Download and print the manual, maps, field day workbook and other information that will be provided to you by Northern Tablelands LLS
- Attend the fully paid for field day on Wednesday 2 May 2018
- Attend one of the tutorials (optional but highly recommended)
- Students can submit an individual entry or a group entry with a maximum of four students per group
- Include a cover page (template shown in Appendix 5) for each entry with the name of your school, class name and all contributing student’s names clearly marked
- Only send the best two entries per class to Northern Tablelands Local Land Services.
2. Glen Innes Agricultural Research and Advisory Station FARM CASE STUDY

Agriculture students from Northern Tablelands schools have been invited to Glen Innes Agricultural Research and Advisory Station (‘the Station’) to undertake a farm case study.

2.1 The Task

Each student or group of students are asked to make an assessment of the current farm system and to develop a property plan incorporating suggested improvements that will enhance future farm profitability and sustainability. The plan will include recommendations for a suitable enterprise mix in line with land capability and which will create a productive, profitable and sustainable farm.

2.2 What is a Property Plan?

A property plan assists the landholder to develop a productive and profitable farming business through improving the natural resource base on their property. Property planning enables landholders to identify what is holding them back, maintain farm financial viability, enhance their capacity to utilise ‘free’ natural resources, manage risks proactively, build resilience to withstand climate variability and develop a framework for fulfilling their farm’s potential. It is:

- A written management plan for a farm business which takes a holistic whole farm approach: property layout, land use, land capability, financial planning, risk management and people management.
- A tool for farmers to clarify their vision and goals, develop management plans to achieve these goals and take action.
- A process that identifies opportunities for business improvement and assists farmers to move towards more sustainable practices through knowledge gained.

2.3 The Property Planning Process

- Develop your vision, values and set goals.
- Assess your current situation.
- Plan actions to take you from where you are to where you want to be.
- Monitor.
- Review and Replan.

2.4 Your Property Planning Competition Task

Students should use the information provided in this manual and the information collected from the Glen Innes Agricultural Research and Advisory Station field day to develop a property plan. Each student or group of students has been hypothetically contracted by the owners of the Station to make an assessment of their current farm production system and to recommend improvements which will enhance future farm profitability and sustainability.

2.3.1 Your Property Plan report for Glen Innes Agricultural Research and Advisory Station will take into account:

- The aims of the hypothetical landholders.
- Natural characteristics of the land, water and vegetation.
• Minimise land and water degradation by identifying existing and potential problem areas and adapting management accordingly.
• Social, legal and economic aspects.
• Maximising profitability through appropriate enterprise selection, production systems and marketing options.
• Appropriate risk management strategies.
• Appropriate monitoring options for recommendations made.

2.3.2 Property Plan Components:
• Mapped physical property plan with recommendations clearly marked.
• A written report explaining these recommendations and addressing the marking criteria (Appendix 4).

Note: Word Limit for written report is 3500 words.

2.3.3 Essential components of your Property Plan:

As per the Marking Schedule (Appendix 4):

1. Consider land capability in land use and management strategy recommendations.
2. Address Land Use Issues identified in this manual and at the field day.
3. Appropriate enterprise selection and suitability in line with landholder aims, labour requirements, profit, farm design, natural resource base, environmental impact and marketing options.
4. All recommendations show consideration of land managers' aims and conditions.
5. Map presentation reflecting the plan.
7. Use of resource information provided: Manual, maps, field day work book.
8. Legal considerations accounted for.
9. Funding considered. Funding options relevant to your recommendations, for example:
   o farm cash flow
   o banks
   o NSW Rural Assistance Authority
   o Northern Tablelands Local Land Services
   o Landcare.
10. Use of other resources.
11. Monitoring.

Figure 1: Property Management Planning (Brouwer 2012)
What the judges look for:

- The marking schedule.
- Presentation.
- Precise, clear and concise report.
- Quality ideas.
- Consistency with landholders’ vision.

Marks will be deducted for exceeding the word limit of 3500 words.

2.5 Report Requirements

To enter the 2018 Property Planning Competition, each student/group of students will need to submit the following:

1. A physical property plan (map with recommendations clearly marked) (see Map 4, Appendix 1)
2. A written report (word limit 3,500 words) explaining the recommendations and addressing the marking criteria (Appendix 4).
3. PROPERTY INFORMATION – Glen Innes Agricultural Research and Advisory Station

3.1 About Glen Innes Agricultural Research and Advisory Station

3.1.1 Location

Glen Innes Agricultural Research and Advisory Station is located at 444 Strathbogie Road Glen Innes, NSW, 2370.

3.1.2 Background

The Glen Innes Agricultural Research and Advisory Station is owned and run by the NSW Department of Primary Industries (DPI). This Station is the research and development base for the Northern Tablelands of New South Wales. Grazing provides the mainstay agricultural activity on the Northern Tablelands. Because of high rainfall, long growing season and the adaptive potential of temperate perennial species, the Northern Tablelands is credited as the premier pasture environment in Australia for intensive grazing systems. As DPI's base for the high rainfall zone in northern NSW, the Station provides research and development programs for eastern Australia's sheep and cattle industries based on temperate perennial pastures. Research and development work at the Station is directed at improving the pasture base for grazing animals, and at developing industry capability to produce livestock products to commercial specifications through:

- building the knowledge base for pasture improvement technology
- managing feed-gaps to address nutritional limitations
- matching livestock genetics to feed and management applications
- developing technology packages for 'best management practice' (DPI 2018).

3.1.3 History

The station was established as The Experiment Farm, Glen Innes (later New England Experiment Farm; New England Agricultural Research Station and Agricultural Research Station, Glen Innes) in 1902 on a portion of an area which was used as a stock reserve.

The aims of the Experiment Farm were:

- to study the agricultural and pastoral problems of the Northern Tablelands;
- to produce improved strains and varieties of both plants and animals suited to the area;
- to improve methods of culture and management of stock and pastures; and
- to conduct research that would be too expensive and perhaps impracticable to be undertaken by private landholders.

Thus the farm was not established to produce commercial quantities of crops, stock and fodder but rather to be self-sufficient as a component of efficient management.

The first activity undertaken was the construction of dams for stock watering followed by clearing and fencing. The vegetation was described as woodland with the main species being
white gum and peppermint with some red gum and apple on the higher parts. Clearing was no easy matter as the trees were large and white gum and peppermint do not burn easily. Some large stumps and stems required teams of up to 40 bullocks to remove them from areas to be cultivated. Much of the early ground breaking was done by bullock teams while latter cultivation was with the horses using stock derived from a Clydesdale stud which was set up on the farm in 1904 and was a feature of the station until 1948. The stud was very well known and exhibited the champion Clydesdale at the 1936 Sydney Show.

The first buildings consisted of a workman’s hut, experimental shed, stables and dairy; the main administration building, Managers residence and other residences were constructed in 1911.

Early investigations were initiated by specialist officers from Head Office who supervised the activities of the local staff. Among the first areas selected were sites for the establishment of an orchard (Mr WJ Allen) and for wheat research (Mr Farrer).

Over the years, research has been carried out into:

- Pastures
- Dairy and beef cattle
- Fruit – apples, pears
- Broadacre crops – wheat, oats, maize
- Tropical and temperate grasses
- Vertebrate pests
- Pigs
- Sheep
- Filbert nuts
- White clover
- Weed biology and control
- Other crops – potatoes, lavender, pyrethrum, tobacco, wine grapes
- Cotton – during the early stages of the Australian cotton industry, Glen Innes was used as a quarantine facility to screen introduced varieties
From circa 1930 research commenced in earnest with an initial focus on plant improvement with wheat, oats, maize, potatoes and tobacco breeding. Shannon Vale Nutrition Station, a remote sub-station of The New England Experiment Farm, was established in 1939 for research on ‘weaner ill-thrift’ - this was a prevalent limitation to sheep performance on the granite soils of the Northern Tablelands. With the solution found in ‘clover & super’ technology, research and extension work for the grazing industries progressed to:

- Maximising production (1960 -70) through pasture agronomy research and animal nutrition studies
- Optimising profitability (1980 -90) through cattle genetics research, sheep fertility innovations and the development of steer ‘backgrounding’ technology
- ‘Best practice’ management for sustainability in the present era.

### 3.1.4 Agricultural Education

Glen Innes was one of the centres of youth education for agriculture in the state. The first students took up residence in the administrative quarters in 1913. Training (at a cost of 10 pounds per year) was basically practical experience with few formal lectures provided. Some students were enrolled free of charge and stayed for a period of six months, engaged in general farm duties as their tuition. Included in these student groups were the ‘Dreadnought boys’ (English boys migrating to this country until 1920). When unfunded students were considered sufficiently proficient they were placed with farmers and graziers as required. When the Dreadnought scheme ended, groups of European migrants were also considered eligible. Many enrolled as students or were given residence to obtain the necessary skills. Groups of up to 40 students were housed at any one time and many became established in the rural industry after gaining experience with their sponsor farmers.

### 3.1.5 Today

The office is shared by other government agencies – Northern Tablelands Local Land Services and WaterNSW. Research is still conducted on beef, sheep, pastures, grasses and weeds (Elvins 2017).
### 3.1.6 Current Farming Operation

As the Station is run as a research facility, the existing livestock enterprises include a cattle breeding herd (consisting of Angus cows and calves, replacement females, bulls and steers), a flock of merino wethers and a cross-bred ewe flock. There are a number of research and/or fodder crops on the station, including oats, maize, red clover and brassicas, as well as improved pastures.

The total area of the Station is 450ha, with an average season carrying capacity of 5,127 Dry Sheep Equivalent (DSE). This is an average stocking rate of 11.4 DSE/ha.

Livestock numbers on hand at the Station on the 27<sup>th</sup> March, 2018 are as follows:

<table>
<thead>
<tr>
<th>Livestock class</th>
<th>Number of Stock</th>
<th>DSE rating (per head)</th>
<th>Total DSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Angus Bulls</td>
<td>13</td>
<td>18</td>
<td>234</td>
</tr>
<tr>
<td>Angus Heifers</td>
<td>13</td>
<td>8</td>
<td>104</td>
</tr>
<tr>
<td>Angus Cows</td>
<td>251</td>
<td>12</td>
<td>3012</td>
</tr>
<tr>
<td>Angus calves/weaners</td>
<td>241</td>
<td>6</td>
<td>1446</td>
</tr>
<tr>
<td>Merino wethers</td>
<td>381</td>
<td>1.2</td>
<td>457</td>
</tr>
</tbody>
</table>

The soil types on Glen Innes Agricultural Research and Advisory Station include:

- chocolate to black basalt
- red-brown basalt
- heavy black to grey clay loam
- grey iron stone

The property is fenced into 59 small paddocks with water provided to each paddock through
dams or troughs (Map 1). The pastures throughout the property have been improved and comprise grasses such as phalaris, fescue, rye, cocksfoot, paspalum, rats tail grass, red grass, broad leaf weeds, red and white clover.

3.2 Landholder’s Aims

Using a research station is something new for the Northern Tablelands LLS Property Planning Competition and some of the objectives of a research station are different to commercial family farms that have been used as examples in the past.

The management of the Station are aiming to increase the carrying capacity from the current 11-12 DSE/ha to 16 DSE/ha. Whilst the focus of the Station is research there is still a focus on running a productive and profitable farm with healthy natural resources and livestock.

3.3 Maps

Students are provided with several maps to assist them to undertake their property mapping (Appendix 1). These maps should assist students to consider infrastructure requirements, water quality issues, livestock, pasture and grazing management and to assist them to develop a biodiversity plan for the property. The maps include:

- **Map 1 ‘Glen Innes Agricultural Research and Advisory Station Infrastructure’** which includes all infrastructure and biophysical information (this should be viewed at large A1 size so that the details of the map can be seen clearly. Teachers will be provided with maps to take back to school after the field day.
- **Map 2 ‘Glen Innes Agricultural Research and Advisory Station Rural Land Capability’** which displays land capability classes for the property.
- **Map 3 ‘Glen Innes Agricultural Research and Advisory Station Biodiversity’** which displays the remnant vegetation types, water catchments and provides a landscape context to the property.
- **Map 4 ‘Glen Innes Agricultural Research and Advisory Station - Student Map’** is a blank map for students to draw their property planning developments onto.
4. STOCKTAKE OF RESOURCES

4.1 Climate

The Northern Tablelands of New South Wales is a cool temperate highlands region between latitudes 28-32°S. Climatic conditions across the Northern Tablelands include relatively high rainfall (average annual rainfall, 750-1250 mm) with summer rainfall dominance, a 200-day frost interval (April - October) and intensely cold winter conditions.

The Station is located at 29° 44′S/151° 42′E in the Northern Tablelands and the altitude is 1057m. Climate is characterised by average annual rainfall of 840mm with summer dominance (36% incidence between December and February), a wide temperature range, and precipitation exceeding evaporation only in winter months. The annual temperature range is 24.5°C, the mean maximum and minimum temperatures in the warmest month (January) are 25.2 and 13.5°C, respectively; the mean maximum and minimum temperatures in the coldest month (July) are 12.4 and 0.7°C, respectively.

Soil moisture has a well-defined seasonal pattern. Despite summer-rainfall dominance, soil moisture is progressively depleted during spring-summer, remains low and variable in late summer-autumn, and is recharged in winter. For pastures, the seasonal growth rhythm comprises high pasture growth during the spring primary growth phase, moderate pasture growth during the secondary growth phase in summer-autumn and low growth in winter. The major climatic stresses for pasture plants are summer-autumn moisture deficit, winter cold and episodic drought (DPI 2018).

Figure 2: Mean maximum temperature for Glen Innes Agricultural Research and Advisory Station 1970-2017
(Source: Bureau of Meteorology 2018)
Figure 3: Mean minimum temperature for Glen Innes Agricultural Research and Advisory Station 1970-2017
(Source: Bureau of Meteorology 2018)

Figure 4: Mean rainfall (mm) for Glen Innes Agricultural Research and Advisory Station 1910-2017
(Source: Bureau of Meteorology 2018)

More climatic information is available at: www.bom.gov.au/climate/data/
4.1.1 Key Points

- **Rainfall amount and seasonality determines the growth of pasture and limits the ability to grow crops in an area. It also influences erosion hazard, flooding hazard and groundwater levels.**
- **The amount of rainfall influences stream flow to lower areas and groundwater levels through deep drainage.**
- **Temperature will affect plant growth and stock nutritional needs; management of the property needs to consider how the effects of temperature can be managed.**
- **Wind speed and direction influences water use by crops and pastures, and is an important consideration when determining sites for wind breaks or stock shelter areas.**

4.2 Contours and Drainage

Glen Innes Agricultural Research and Advisory Station sits at the top of the Great Dividing Range, in the headwaters of the Murray-Darling Catchment. There are no permanent streams on the property but during wet periods the ephemeral Donnelly’s Creek drains water from the property into Reddestone Creek which runs north to the Severn River. These creeks and the smaller drainage lines marked on Map 3 (Appendix 1) will influence the way that the property may be best managed. The map also shows contours, which represent lines of uniform elevation, with a constant interval in height between them. This means that where contours are spaced more closely together, the land surface is steeper, so may require conservative management to offset the potential erosion hazard. The contour lines range from 1,040m to 1,080m above sea level with some parts of the property having gentle undulations and others being flat. Salinity is not considered to be an issue on this property as this region is not prone to salinity.

4.2.1 Key Points

- **Drainage lines, watercourses and riparian vegetation must be retained and carefully managed. They are especially at risk of erosion if cultivated or overgrazed.**
- **Often these areas contain native vegetation and are important for biodiversity.**
- **Streams require flows periodically to maintain riparian vegetation. It is important not to cut off the small flows to streams, riparian areas and aquatic ecosystems in dry periods.**
- **Maintaining flow in watercourses and streams is important for environmental reasons, for downstream stock and domestic water supply, and for downstream agriculture and industry.**

4.3 Infrastructure

Glen Innes Agricultural Research and Advisory Station is fenced into 59 paddocks varying in size from 1.5ha to 18ha. There are five dams, one bore and many water troughs (Map 1).

Glen Innes Agricultural Research and Advisory Station currently maintains the following facilities:

- Heritage-listed buildings with office, administration and conference facilities connected to DPI’s state-wide computer network
- Three cottages accommodating on site DPI staff
• Bureau of Meteorology weather station (Meteorological Station 056013)
• Seeds laboratory, field plots nursery and demonstration pastures
• Modern cattle yards, sheep yards and shearing shed
• Extensive range of agricultural equipment and machinery for field operations ranging from trial plots to large scale farming enterprises, fencing and internal laneways for the safe and efficient handling of livestock, and storage facilities for hay and grain (DPI 2018)

Tree revegetation and regeneration areas across the property have been planted since 1990 and cover an area of 19.5ha. All infrastructure can be viewed on Map 1 (List of species can be found in Appendix 2).

4.3.1 Key Points

• Glen Innes Agricultural Research and Advisory Station’s infrastructure is designed to suit the current enterprises of livestock. Some infrastructure (such as dams) are relatively permanent features, whereas electric fences, troughs and gates can be repositioned or constructed elsewhere if this best meets the management needs of the property.
• Fencing should be designed to match the enterprise that is operating on the farm. Every time you cross a soil or landscape boundary you are entering a new enterprise/land capacity, with different production potential. Managing one soil and landscape type in each paddock is best for developing meaningful records such as soil tests when trying to identify causes of production loss.

4.4 Vegetation

Native trees, midstoreys and understoreys are an integral and important part of the landscape and have a major role in catchment management. In the past, native vegetation across the property would have ranged from Eucalypt open forest or woodland through to native grassland. The current distribution of vegetation on and around the property can be observed on Map 3 ‘Biodiversity’ (Appendix 1). ‘Vegetation of Glen Innes Agricultural Research and Advisory Station’ (see Appendix 2) contains a species list for trees, shrubs, groundcovers and other plants potentially found on and around Glen Innes Agricultural Research and Advisory Station.

4.4.1 Benefits of Native Vegetation

For producers, the benefits of native vegetation include better stock shelter, protection from erosion, improved water quality, increased habitat for wildlife with a corresponding decrease in pest insects, increased property value due to aesthetics, timber sources and many more benefits. An increase in the amount of strategically placed and managed native vegetation can result in an increase in biodiversity (the variety of plants and animals in an area) and a healthier, functioning ecosystem. A healthy ecosystem will then provide ecosystem services to landholders, such as cleaner water for stock, more resilient pastures and biological pest control which will result in higher returns (Miller et al 2013). For example, at the Station, planted native vegetation next to a brassica crop provides habitat for birds that eat insect pests that could damage the crop (see photo).
4.4.2 Remnant Vegetation

This area was once all covered in native vegetation – clearing was extensive in the 1900s. This resulted in the landscape looking as you see it today. There is some vegetation which was not cleared and still remains. This is what we call remnant vegetation. Remnant vegetation often occurs along rivers or gullies, in clumps on poorer soil or on ridge tops. But not all remnant vegetation is the same quality – some will be very degraded, other patches may have a lot of diversity and features which make it high quality. During the farm visit, students will be asked to conduct a Bushland Health Check to assess the health of the remnant vegetation on Glen Innes Agricultural Research and Advisory Station.

Remnants, or fragments, of native vegetation are more susceptible to influences from the cleared or developed land that surrounds them. Influences can include uncontrolled grazing, weed invasion, drift from herbicide or fertiliser, increased light, wind and temperature variation leading to increased drying out, and increased predation of native fauna by feral animals. These influences occur mostly at the edges of remnants and are called ‘edge effects’.

Remnants of native vegetation with relatively long edges (like windbreaks or roadsides) have a greater edge to area ratio than square or rounded blocks of native vegetation, making them quicker to degrade. Isolation of remnants of native vegetation leaves the species within them less able to migrate and more prone to catastrophic events such as fire, flood or drought. This eventually causes local and regional extinctions.

It is important to consider vegetation in a landscape context. That is, to look beyond the boundaries of the property to see where corridors exist or can be recreated, and where areas of key habitat can be found. In extensively cleared areas of the catchment, native plants and animals dependent on native vegetation are restricted to pockets of remnant vegetation of varying sizes. Many fauna populations within individual remnants are so small that they are at risk of extinction from a number of different pressures. Often waterways provide corridors where riparian vegetation has not been cleared. Travelling Stock Reserves and roadsides can also provide important corridors through the landscape, connecting ‘islands’ of remnant vegetation amongst a ‘sea’ of cleared agricultural land. Patches of remnant vegetation need to be connected in order for species to survive. It is recommended that patches must be a minimum of 10 ha in size and connected by stepping stones (corridors, paddock trees etc.) which are less than 100m apart. Overall the gap between habitat patches must be less than 1.1km with stepping stones in between.

The remnant vegetation on the property can be made healthier by connecting patches of remnant vegetation by planting new corridors. Planting supplementary native vegetation in existing remnants to boost regeneration and managing grazing (e.g. no grazing during early stages of plant growth then ‘crash’ grazing - high intensity grazing for short periods) will also increase the health of the bushland.
4.4.3 Existing Vegetation

Most of Glen Innes Agricultural Research and Advisory Station is cleared agricultural land however there are remnants of native vegetation found nearby on nearby Travelling Stock Reserves (TSRs) and farms (see Map 3, Appendix 1). A small portion (approximately 8ha) of the Station is mapped as Box – gum grassy woodlands. This ecological community is listed as endangered under the NSW Biodiversity Conservation Act 2016 and critically endangered under the Federal Environment Protection and Biodiversity Conservation Act 1999. A flora list is also included in Appendix 3.

4.4.4 Farm Trees

Farm trees effectively save water by slowing wind, cooling the surface by shade and so decreasing evaporation from the soil surface and by improving soil structure. This in turn increases soil permeability. To be most effective, these trees would be placed up-wind and through the landscape. Trees also manage rising water tables by drawing moisture from deep in the ground and improving soil structure. Trees are deep rooted and can be used to help lower the water table and thus reduce the potential for salinity. They must, however, be placed in the correct position within the landscape to have this effect.

4.4.5 Key Points

- As this property has been cleared and modified, it is unlikely that natural regeneration would occur. In order to increase the area of native vegetation, it would have to be planted.
- The location of windbreaks and wildlife corridors need to be determined after considerations such as boundaries, roads and powerlines.
- To reduce wind speed on productive areas, utilise high points in the landscape to increase effectiveness of planted wind breaks. Plants in windy areas use water less efficiently.
- Vegetation should be connected, have some larger remnants, be as close as possible, orientated at right angles to the prevailing winds, contain a mix of species, trees and shrubs, and a range of age. If you are recommending establishment of native vegetation, you should consider factors such as selection of suitable tree species and consider windbreak design, tree
planting techniques, methods of excluding stock and weed control.

4.5 Biodiversity

4.5.1 Ecosystem Services

The natural environment provides ecosystem services which are defined as the benefits that people obtain from ecosystems (Millennium Ecosystem Assessment 2005). Agriculture depends on a range of vital ecosystem services, such as healthy soils, nutrient cycling, waste decomposition and water capture and filtration.

The diversity of genes, species and ecological processes makes a vital contribution to ecosystem services. Biodiversity provides important pollinators, seed dispersers and pest control agents on which agriculture depends.

More generally, by providing multiple species that fulfil similar functions but have different responses to human landscape modification, biodiversity enhances the resilience of ecosystems. Maintaining biodiversity in production landscapes therefore often constitutes an economically profitable synergy between conservation and production (Fischer et al 2006).

The CSIRO suggests that to maintain the ecological integrity of agricultural landscapes requires 30% of native vegetation in multipurpose areas on farm, while an additional 10% should be included for pure conservation. Research has found (all references sourced from Miles et al 1998):

- a 20-30% higher yield was obtained in protected than in unprotected areas of a farm, with annual benefits of $39 to $66 per hectare (Fitzpatrick 1994 – mainland Australia)
- a 20% increase in average pasture growth was estimated for protected areas of a farm (Radcliffe 1983 – Australia and overseas)
- gross value of pasture output is at its highest level when the proportion of tree area is at 34%. Note that this figure relates to natural remnant of bushland rather than shelterbelts or windbreaks (Walpole 1998 – Gunnedah NSW).
4.5.2 Conserving Biodiversity on Farms

Northern NSW has the highest diversity of marsupial, frog and snake species in Australia. However the number of animal species present on the Northern Tablelands and North West Slopes and Plains has fallen alarmingly since the 1840s, with one species becoming locally extinct every ten years. Unfortunately the extinctions of animals and plants will most likely continue with 160 species listed as threatened.

Agricultural practices and pest animals are blamed for most of these extinctions. Agriculture is an integral part of the region’s social fabric and economy, so we have to find ways to integrate conservation and agriculture. For example, many of our woodland birds are disappearing as the shrub layers in their habitat are lost to clearing, grazing and fires.

Everyone living on the Tablelands has a role to play in protecting habitat - on private and public land - to help stop animal extinctions, whilst pursuing sustainable agriculture. The conservation of wildlife requires efforts to protect and enhance the complex habitat features in remaining forests, woodlands and grasslands. Many animals use more than one component of habitat e.g. Yellow-tufted honeyeaters feed on nectar in the canopy of trees but build their nests closer to the ground, in the shrubby understorey. Glossy black cockatoos require large tree hollows for nesting and a reliable source of mature fruiting native oak (Casuarina and Allocasuarina) trees for feeding. A fauna list for Glen Innes Agricultural Research and Advisory Station can be found in Appendix 3. Glen Innes Agricultural Research and Advisory Station is located near key habitat and corridors for fauna species such as the koala, spotted-tailed quoll and regent honeyeater. Stepping stones of vegetation on farms provide important linkages between larger habitat patches such as Mann River Nature Reserve and Kings Plains National Park.

4.5.3 Management Actions

Farmers can undertake simple actions to manage and increase biodiversity on their land, including:

Manage Existing Bushland

- Fence to manage grazing
- Control weeds
- Control feral animals
- Manage fire
- Make bushland patches bigger
- Increase the number of plant species

Manage Existing Paddock Trees

- Keep and protect paddock trees

Manage Grassland / Native Pasture

- Manage grazing
- Maintain high groundcover
- Increase species diversity
Revegetate

- Create new bushland patches
- Plant scattered trees
- Create wildlife corridors
- Plant shelterbelts or alley-farming
- Protect, restore, enhance and increase riparian buffers
- Consider farm forestry
- House and shed plantings (provide habitat for fauna)
- Create seed production areas (for use in revegetation work)
- Create bug banks (dense planting of flowering shrubs among crops)
- Roadside plantings (fill in gaps of vegetation near important roadside corridors)
- Plant mid-paddock clumps for protection of stock and use by wildlife

4.5.4 Key Points

Looking at the landscape level, each individual property needs to protect the ecosystem services it can provide in order to maintain a functioning ecosystem. Issues such as providing habitat, protecting beneficial fauna and maintaining healthy waterways must be considered in the broader landscape context.

4.6 Land Capability

Farm planning is about designing a sustainable farming system that takes into account land capability so the farm can be managed to reduce present and prevent future land degradation. Your farm plan will identify landscape characteristics and help you plan to match land use to land capability. Land capability is an essential part of mapping your farm’s resources. A land capability map is a set of guidelines for how your property should be managed sustainably which tells you which parts should be cropped, which parts should be grazed and areas that are best left in their natural state. By identifying how to manage the land sustainably within its land capability you are ensuring your management decisions will not cause your land resource to deteriorate. Land capability is not determined by the current land use but rather it is based on its potential for sustainable land use if developed.

The term land capability refers to “the ability of land to sustain a type of land use without causing it permanent damage”. In New South Wales there are eight classes within the land capability assessment system, and these are classified according to soil type, slope and erosion risk (see Table 1). These factors influence how you manage your land and the production techniques you use. Farming beyond the limitations of the land, by over-grazing or cultivating on inappropriate areas, can leave soil vulnerable to erosion. It is important to identify the different land classes on your property and manage them within their limitations. This will reduce the risk of erosion occurring on your farm.

Table 1 describes the eight class system that was used to classify land on Glen Innes Agricultural Research and Advisory Station (refer to Map 2, Appendix 1), and indicates how each may be best managed to maintain its productivity and sustainability. The Station is mapped with land classes II, III and IV. The photo to the right shows a paddock considered to be class II at the Station.
### Table 1: Land Capability classes

<table>
<thead>
<tr>
<th>Land class</th>
<th>Soil conservation practices</th>
<th>Brief description</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>No special soil conservation works or practices required.</td>
<td>Usually flat land that is suitable for a wide variety of uses. When it is fertile it can be used for almost anything including fruit and vegetables, sugar cane, cereal crops and other grain crops.</td>
</tr>
<tr>
<td>II</td>
<td>Soil conservation practices such as strip cropping, minimum tillage and crop rotation.</td>
<td>Gently sloping land suitable for many agricultural uses. Good cropping land on fertile soils. Low erosion potential.</td>
</tr>
<tr>
<td>III</td>
<td>Structural soil conservation works required, conservation tillage techniques and crop rotation.</td>
<td>Sloping country that is likely to wash and erode when cultivated. The land is quite fertile and adequate for cropping as long as soil conservation practices such as contour banks are used.</td>
</tr>
<tr>
<td>IV</td>
<td>Soil conservation practices such as pasture improvement, stock management, fertiliser application and minimal cultivation for pasture establishment and maintenance.</td>
<td>Good grazing country but not suitable for the practices listed in I to III. Main limitations are slope, rockiness, soil fertility, and susceptibility to soil structure decline. Maintenance of good ground cover is essential.</td>
</tr>
<tr>
<td>V</td>
<td>As above, as well as absorption banks, diversion banks and contour ripping.</td>
<td>Not suitable for cultivation on a regular basis owing to slope gradient, soil erosion, shallowness or rockiness, climate, or a combination of all of these factors. Soil erosion problems are often severe.</td>
</tr>
<tr>
<td>VI</td>
<td>Limitation of stock, aerial spreading of seed and fertiliser. May include some isolated structural earthworks.</td>
<td>Comprises the less productive grazing lands that should not be cultivated because of soils, slope, wind or water erosion hazard. Requires sound grazing management and pasture improvement.</td>
</tr>
<tr>
<td>VII</td>
<td>Land best protected by green timber or undisturbed ground cover.</td>
<td>Too fragile for grazing.</td>
</tr>
<tr>
<td>VIII</td>
<td>Unsuitable for agricultural production.</td>
<td>Cliffs, lakes or swamps etc. Not capable of sustaining agriculture.</td>
</tr>
</tbody>
</table>
4.7 Land Management and Erosion Risk
From the description of land classes on the previous page, there is a clear link between those classifications and the risk of erosion. All land classes of Class III and above are at some risk of erosion if land management practices are not tailored to work within their limitations.

To decide what class, or classes, your farm fits into you need to have a good idea about the soil types on your farm. Soil boundaries may follow land class boundaries. However, different soil types can also occur within the one land class and are more prone to erosion and require different management. For this reason it is advisable to do some basic soil tests.

Land management practices targeted at reducing erosion risk are generally also good for overall soil health. Maintaining or establishing well vegetated paddocks will lead to better soil structure, and plant water availability. These improvements will ultimately lead to better productivity, resulting in a win-win situation - reduced erosion and increased productivity.

4.7.1 Key Points
Using information on contours and soil, and Map 2 ‘Rural land capability’, consider what land use enterprise options and management are best suited to this property. There are several different enterprises that could be run on Glen Innes Agricultural Research and Advisory Station. Students should consider the best land use and discuss whether they would recommend the current land uses or others.

It is more economical to manage productive land better, than it is to try and convert less productive land to a higher production standard. Less productive land can still be utilised to perform important functions within the property. Fencing to soil type or land capacity may make expenditure eligible for tax deduction in the year of construction.

4.8 Soils
Soil is the main resource upon which plant and animal production depends, so it is essential to understand the features that determine the ability of a soil to support such production, and to be resilient towards degradation.

4.8.1 Soil Types on Glen Innes Agricultural Research and Advisory Station
Basalt soils: are the more fertile and productive soils, having good natural fertility of nutrients and organic matter. There are 3 main types of basalts ranging from red to chocolate and black. The red basalts are deep, free draining, being moderately fertile, slightly acid and used more for intensive agriculture. However severely leached red basalts can be extremely acidic containing excessive aluminium and/or manganese. Chocolate basalts are shallower, moderate to slightly acid, moderate fertility and frequently quite stony. Black basalts are the most fertile although can become phosphorus deficient after intensive cropping. These vary from self-mulching, cracking soils to heavy clays and poorly drained soils and are usually slightly acid. Characteristics of basalt soils include:
- High natural fertility
- Can be rocky and non-arable
- Often sulphur, molybdenum and selenium deficient

**Heavy black/grey clay loams**: still belong within the broad category of basalts but more of an alluvial origin. High organic matter and natural fertility but past history (cropping etc.) leading many to be now of medium to low fertility requiring the addition of nutrients for maximum production. High clay content plus some chemical imbalances and soil physical characteristics, make management more challenging e.g. low calcium:magnesium ratio, high manganese in sub soil, poor drainage. Soil pH can vary from highly acid pH 4.0 CaCl₂ to slightly acid pH 6.5 CaCl₂. Soil acidity generally decreases (becomes more acid) with soil depth. Characteristics of these soils include:

- High natural fertility but many now moderate to low fertility
- Arable but have limitations due to physical and chemical characteristics
- Often sulphur and molybdenum deficient.

**Grey Ironstone**: usually fit into the commonly referred to soil category of traprock soils which can come from sedimentary or igneous origin. Of the “trap” soils, grey ironstone is the more fertile because of its igneous origin. Compared to other soil types these are considered medium to low fertility, low organic matter, moderately acidic (low soil pH) and are shallow (small A horizon). Because of the shallow soil they are prone to dry period/droughts, are quickly degraded by cultivation, plus introduced temperate pasture species are difficult to establish and maintain. With low soil pH and high iron content, fertiliser efficiency particularly with phosphorus can be reduced. Characteristics of these soils include:

- Medium to low fertility of major nutrients - nitrogen, phosphorus and sulphur
- Some trace elements can also be deficient such as molybdenum and boron
- Shallow soil reducing flexibility of enterprise and pasture type selections.

### 4.8.2 Definitions and Information for Soil

**Soil texture** describes the relative proportions of sand (large particles), silt (small particles) and clay (tiny particles) in a soil. Texture indicates the ease with which a soil can be worked and its capacity to hold water and nutrients. Texture also affects the ability of a soil to handle machinery traffic, and its susceptibility to erosion.

**Soil pH** is a measure of the acidity or alkalinity of a soil. It is an important factor in determining the availability of nutrients and trace elements to plants. At low pH for example, nutrients such as Phosphorus become deficient, while others such as Aluminium become available in toxic amounts.

**Soil colour** gives a good guide to the level of organic matter, degree of leaching and level of drainage. Red and brown soils indicate good drainage and are usually found higher on ridges and upper slopes. Yellow, grey and mottled soils are indicators of less well drained soils and are usually found in lower areas and on drainage lines.

**Soil structure** refers to the arrangement of soil particles, the strength of the bonding between them and the size and distribution of the pores throughout the soil. Structure plays an important role in determining the ability of a soil to absorb and to hold water and air. Also, the ease with which seedlings may emerge from and roots may penetrate the soil.

**Soil fertility** refers to the ability of a soil to provide a plant with the nutrients essential for growth, and also the absence of toxic species.

The **rate of infiltration** of soil affects the possible amount of run-off and recharge to groundwater.

**Soil salinity** refers to the presence of salt in the soil. A high salt level is toxic to plants, and may cause poor pasture growth and reduced crop yield, and in extreme cases, bare patches of unproductive land.
**Sodicity** and subsoil constraints. Depression and presence of Manganese or Iron nodules. **Organic matter** helps bind soil together which maintains good structure and water holding capacity. It acts as a mulch and encourages soil biota which assist in nutrient cycling.

### 4.8.3 Soil Erosion

Soil erosion occurs if land is managed beyond its capability. Management of soil erosion relies on good land practices being adopted. In some cases remedial earthworks may be required however these need to be well planned as ground disturbance can often lead to greater problems. It is imperative that they be used in conjunction with good land management practices.

In areas subject to erosion, suitable control structures may include contour banks, levees, pasture belts and waterways, gully filling and gully control weirs and dams. Structures that control water erosion are designed to slow water down before it can cause erosion. It may be channelled via water ways and contours into small gullies and creek lines. In some cases the water is diverted into dams to store and slow water. Water directed into dams can add to the farm water supply.

Any erosion control program that involves diversion of run-off must provide for safe disposal of that water. When considering the disposal of run-off water it is important to identify the flow-lines and point or points at which water naturally leaves the property.

### 4.8.4 Key Points

*Consider the possibility of erosion by looking at information on land capability and soil type. If you determine contour banks are necessary, indicate the flow direction of the run-off water along the contour banks.*

*There is a legal obligation to ensure that there is no diversion of run-off from one exit point to another. Once these exit points are known it is then possible to design and locate a system of erosion earthworks.*

*The modification of catchments through soil erosion control works that alters the way water is delivered to watercourses may affect stream behaviour and stability. When undertaking soil erosion works the impact on downstream areas should be considered.*

### 4.9 Water Quality

#### 4.9.1 Severn River Catchment

A catchment is an area of land catching rainfall that flows into a creek, river, wetland or the ocean. Hills or ridges separate each catchment and direct the flow of water into different waterways. Within catchments, there are natural features such as native vegetation, water, rocks and soils. However, catchments are also the places where people live, work and play. Human use in catchments can have an impact on water quality. This will affect the availability of water for a variety of uses.
Catchments occur at a variety of scales from very large catchments such as the Murray–Darling Basin to local creeks and streams that may only flow occasionally. The interconnectedness of catchments means that changes in water quality in small local catchments will impact on larger creeks and rivers downstream.

Catchments require management to be sustainable for future generations. Sustainable management will maintain and improve the quality of natural resources within a catchment and meet the needs of the community, ecosystems and the environment.

Glen Innes Agricultural Research and Advisory Station is situated in the head waters of the Severn River catchment which flows into the Murray-Darling Basin and eventually enters the sea in South Australia. In the upper reaches of the catchment, such as mountain regions or foothills, rivers are usually fast flowing. This means they have the energy to carry large pieces of rock and gravel eroded from stream beds and banks. Vegetation along the banks (riparian) provides a buffer from overland flow, reducing the input of sediment and nutrients. The upper parts of a river system are very important to the health of the entire river because this is the source of much of the food carried downstream. Dams and weirs impede the distribution of food and seeds and the migration of aquatic animals, as well as altering flow rates and flood frequencies. Overhanging vegetation provides much of the food (in the form of leaves, fruits, seeds, twigs and bark) required by stream organisms such as macro invertebrate ‘shredders’, which convert coarse material to finer fragments. These macro invertebrates (water bugs) are adapted to fast moving water, e.g. by having streamlined bodies.

4.9.2 Healthy Catchments and Rivers

A healthy catchment is one that is sustainable and able to meet the needs of the community, ecosystems and the environment. The health of a waterway can be measured by characteristics such as:

- Water quality measured by physical, chemical and biological parameters.
- Healthy ecosystems with a high biodiversity. This includes both aquatic and terrestrial ecosystems, especially along riverbanks.
• The resilience or capacity of the ecosystem to maintain its structure and function in the presence of stress. This may be caused by natural factors such as floods or human-induced change.

Land use is a key factor determining the health of waterways. Human activity can impact on river health by influencing the interactions between natural resources (land, water, vegetation and soils) and between aquatic and terrestrial ecosystems. For example, agricultural land uses such as general crops and pastures can lead to the removal of groundcover which can cause erosion and rising water tables. Runoff can pollute water with nutrients, sediments and pesticides. Poor irrigation and land use can lead to salinity problems. Some of the water quality tests that might be used to assess if water quality has been impacted include:

• Presence of macro invertebrates
• Presence of algae
• Stream vegetation overhang
• Dissolved oxygen
• Turbidity
• pH
• Phosphates
• Salinity (EC)
• Habitat assessments

During the Farm Case Study field day, students will use some of these tests to assess water quality and to recommend improvements to property management.
4.9.3 Water on Farms

It is important to maintain good water quality on farms:

- For stock watering
- For the health of aquatic animals
- Downstream users – what kind of water is heading to neighbouring properties?
- It can tell us a bit about the catchment, where the water is coming from and any problems that we can address by planning

Stock need to drink water that has low turbidity, low salinity and neutral pH. For example, consider the effect of pH on stock: Water for domestic and stock use should be in the pH range of 6.5 to 8.5. If the pH is highly acidic (less than 5.5), acidosis and reduced feed intake may occur. Highly alkaline water (over 9) may cause digestive upsets and diarrhoea, lower feed conversion efficiency and reduce intake of water and feed.

Table 2: Effect of Saline Water on Stock

<table>
<thead>
<tr>
<th>Livestock</th>
<th>No adverse effects on animals expected.</th>
<th>Animals may have initial reluctance to drink or there may be some diarrhoea, but stock should adapt without loss of production.</th>
<th>Loss of production and a decline in animal condition and health would be expected. Stock may tolerate these levels for short periods if introduced gradually.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poultry</td>
<td>EC in μS/cm 0 to 3100</td>
<td>EC in μS/cm 3100 to 4700</td>
<td>EC in μS/cm 4700 to 6300</td>
</tr>
<tr>
<td>Beef cattle</td>
<td>EC in μS/cm 0 to 6300</td>
<td>EC in μS/cm 6300 to 7800</td>
<td>EC in μS/cm 7800 to 15,600</td>
</tr>
<tr>
<td>Dairy cattle</td>
<td>EC in μS/cm 0 to 3900</td>
<td>EC in μS/cm 3900 to 6300</td>
<td>EC in μS/cm 6300 to 10,900</td>
</tr>
<tr>
<td>Sheep</td>
<td>EC in μS/cm 0 to 7800</td>
<td>EC in μS/cm 7800 to 15,600</td>
<td>EC in μS/cm 15,600 to 20,300</td>
</tr>
<tr>
<td>Horses</td>
<td>EC in μS/cm 0 to 6300</td>
<td>EC in μS/cm 6300 to 9400</td>
<td>EC in μS/cm 9400 to 10,900</td>
</tr>
<tr>
<td>Pigs</td>
<td>EC in μS/cm 0 to 6300</td>
<td>EC in μS/cm 6300 to 9400</td>
<td>EC in μS/cm 9400 to 12,500</td>
</tr>
</tbody>
</table>

4.9.4 Watering Systems

In order to maintain good water quality for the benefit of stock and the environment, it is important to design a watering system to support this. Watering systems can include a reticulated system of pipes, pumps, tanks and troughs, or on some farms stock access waterways directly to drink water. Stock access to waterways can impact on water quality by stock ‘pugging’ in the muddy banks, causing them to become boggy and the water to become contaminated with suspended soil and faeces. This may cause stock to reject the water and impact on water quality downstream. Also, animals in weak
condition may become bogged and die. The reticulated watering system avoids these problems by keeping stock out of waterways.

4.9.5 Key Points

In order to protect water quality, riparian vegetation should not be removed and livestock are best watered through a reticulated water system which prevents them from damaging watercourses and dams. Retaining vegetation on property also helps to prevent erosion and salinity problems. Stock need clean, fresh water in order to maintain good health and put on condition.

4.10 Salinity

4.10.1 What Causes Salinity?

Changes in land use since European settlement from woodland to grazing and crops have changed the hydrology in some areas. Trees and deep-rooted perennial pastures have been replaced with more shallow rooted species. This means that moisture found at depth cannot be pumped out by evapo-transpiration. This leads to an increase in the excess water in the soil across the landscape and causes a rise in the water table which causes salts to rise through evaporation and accumulate in the soil surface. Salt toxicity impacts plant growth and cell functions. Salinity in the subsoil above a scalded site will also limit pasture production as roots will not penetrate salty soil layers. This also results in a reduced capacity for plant roots to extract water at depth.

4.10.2 Site History

Salinity is not currently a problem at Glen Innes Agricultural Research and Advisory Station however it is still important to consider in preparing a property plan in this region.

4.10.3 Indicator Plants

Indicator plants are a group of species that provide us with an indication of the presence of salt in the soil and a shallow water table. These species are known to tolerate high levels of salt. The following table identifies those salinity indicator plants which may be found at saline sites. Some of these plants may also prefer wet conditions, so it is important to check whether salt incursion is occurring.

Table 3: Indicator Plants

<table>
<thead>
<tr>
<th>Plant species</th>
<th>Botanical name</th>
<th>Salt tolerance (Low/medium/high)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sea barley grass</td>
<td>Hordeum marinum</td>
<td>High</td>
</tr>
<tr>
<td>Rhodes grass</td>
<td>Chloris gayana</td>
<td>High</td>
</tr>
<tr>
<td>Native panic</td>
<td>Panicum buncii</td>
<td>High</td>
</tr>
<tr>
<td>Couch grass</td>
<td>Cynodon dactylon</td>
<td>Medium</td>
</tr>
<tr>
<td>Swamp fox tail</td>
<td>Pennisetum sp.</td>
<td>Medium (prefer damp conditions)</td>
</tr>
<tr>
<td>Wallaby grass</td>
<td>Rytidosperma sp.</td>
<td>Low</td>
</tr>
<tr>
<td>Rats tail fescue</td>
<td>Sporobolis creber</td>
<td>Low</td>
</tr>
</tbody>
</table>
4.10.4 Soil Salinity Test Results

**Table 4: Soil salinity classes**

<table>
<thead>
<tr>
<th>Class</th>
<th>ECe dS/m</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-saline</td>
<td>&lt;2</td>
<td>Salinity effects mostly negligible</td>
</tr>
<tr>
<td>Slightly saline</td>
<td>2-4</td>
<td>Yields of very sensitive crops may be affected</td>
</tr>
<tr>
<td>Moderately saline</td>
<td>4-8</td>
<td>Yield of many crops affected</td>
</tr>
<tr>
<td>Very saline</td>
<td>8-16</td>
<td>Only tolerant crops yield satisfactorily</td>
</tr>
<tr>
<td>Highly saline</td>
<td>&gt;16</td>
<td>Only a few very tolerant crops yield satisfactorily</td>
</tr>
</tbody>
</table>

**Table 5: Tolerance levels for different crops and plants**

<table>
<thead>
<tr>
<th>Crop</th>
<th>ECe dS/m</th>
<th>Plant</th>
<th>ECe dS/m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lucerne</td>
<td>2</td>
<td>Green Panic</td>
<td>5.6</td>
</tr>
<tr>
<td>Sunflowers</td>
<td>5.5</td>
<td>Couch grass</td>
<td>6.9</td>
</tr>
<tr>
<td>Wheat</td>
<td>6</td>
<td>Barley</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Salt Bush</td>
<td>12</td>
</tr>
</tbody>
</table>

4.10.5 Key Points

*Preventing salinity problems is much easier and cheaper than trying to fix them. Maintaining deep rooted perennial vegetation and monitoring indicator plants are good ways to avoid and monitor salinity in the environment.*
5. BIOSECURITY

5.1 What is Biosecurity?
Biosecurity is the set of measures for protecting a population at the national, regional and farm level. The object is to protect the economy, environment and community from the negative impacts associated with diseases, pests, weeds, toxins and chemical residues.

5.2 Farm Biosecurity
Farm biosecurity is defined as reducing the risks to a farm business by limiting the likelihood of introducing or spreading animal diseases, pests, weeds etc. Most biosecurity measures are very simple and low-cost and should be part of regular management routine. Such biosecurity practices will go a long way to securing a farm and its future.

The benefits of implementing biosecurity practices include:

- Greater productivity on farm – better livestock and plant health generally leads to higher productivity.
- Reduced risks on farm – less disease, pests and weeds entering the property and requiring action.
- Early detection and management of any pest, weed or disease – catch the problem before it takes a hold.
- Reduced costs if there is an outbreak of disease, weeds or pests – faster, easier and cheaper eradication and, in some cases, quarantine.

5.3 Priority Areas for Farm Biosecurity
The key areas that farm biosecurity focuses on to reduce risk include:

- New livestock (introducing livestock from other properties onto a farm)
- Purchasing and storing feed, bedding and water
- Restricted animal material and swill feeding
- Moving animals off your property
- Taking animals to shows and sales
- Animal husbandry (livestock monitoring, drenching, vaccinating)
- Fences (to prevent straying stock)
- Chemical usage
- General farm hygiene and maintenance (Animal Health Australia 2012b)

5.4 Livestock Diseases
On-farm biosecurity is about managing risks to meet the following goals:

- To prevent the introduction of infectious diseases to grazing livestock production properties
- To prevent the spread of diseases from an infected property to an uninfected property.

Most disease threats can be controlled before animals enter the property by putting in place an effective biosecurity plan that includes:

- only allowing healthy stock through the farm gate
• a period of on-farm quarantine for all arrivals to monitor and confirm their health status in isolation from your own stock
• effective vaccination or preventive treatments against diseases already known to be on the property

More information is available on various NSW DPI Agfacts or, importantly, specific information for specific disease problems can be obtained from Local Land Services District Veterinarians or Biosecurity staff.

5.5 Toxins and Chemical Residues
Chemical residues are chemicals that are applied to crops, animals, water or soil that leave residues which break down over time. Common residues include:

- banned organochlorines that are persistent in soils
- antibiotics and drenches
- pesticides and external parasite products
- heavy metals such as Lead or Cadmium
- other agricultural chemicals

Residues need to be kept out of the food chain by:

- carrying out on-farm investigations to identify sources of residues
- eliminating the source of the residue or mitigating its effects
- investigating residue detections reported from abattoirs
- using tracing systems such as National Livestock Identification Scheme (NLIS) to identify the source of a contamination
- following withholding periods on chemical labels

Certification that livestock are free of disease and residues is essential for continued and competitive access to domestic and international livestock markets.

5.6 Pest Animals
In Australia, pest animals have major economic, environmental and social impacts. Many pest animals cause significant damage to crops and seriously affect Australia’s livestock industries by preying on stock and competing for pasture. Pest animals also cause severe land degradation by promoting soil erosion, stream turbidity and the spread of weeds. Competition, habitat destruction and predation by pest animals threaten the survival of many of Australia’s native plants and animals (Department of Environment Water Heritage and the Arts 2009a).

Australian private and public landholders and managers spend considerable time and money addressing the impacts of pest animals. For example, it has been estimated that eleven of Australia’s major pest animals (wild populations of foxes, pigs, rabbits, mice, goats, carp, dogs, cane toads, camels, cats and horses) have negative impacts in Australia valued at over $720 million per annum (McLeod 2004).
Species currently declared pests in NSW are:

- **wild rabbits** (*Oryctolagus cuniculus*)
  - feral rabbits compete with native wildlife, damage vegetation and degrade the land. They ringbark trees and shrubs, and prevent regeneration by eating seeds and seedlings. Their impact often increases during drought and immediately after fire, when food is scarce and they eat whatever they can. Feral rabbits have contributed to the decline in numbers of many native plants and animals (Australian Government 2004a).

- **wild dogs** (*Canis familiaris*)
  - some domestic dogs and native dingoes have "gone wild" killing sheep and calves, ground-living birds, reptiles and native animals. They can have a significant impact on agricultural production and farm profitability.

- **feral pigs** (*Sus scrofa*)
  - feral pigs are environmental and agricultural pests. They cause damage to the environment through wallowing, rooting for food and selective feeding. They destroy habitat for native plants and animals and spread environmental weeds. Feral pigs destroy crops and pasture and they could spread exotic diseases should there be an outbreak (Australian Government 2004b). Feral pigs will eat anything from small animals to ground-nesting birds, their eggs and chicks. They are responsible for the degradation of wetlands, cause erosion, disturb rainforest floors, dig up root systems and interfere with the regenerative cycle of native vegetation. Feral pigs can carry infectious zoonotic diseases (diseases naturally transmitted from animals to people) including brucellosis, leptospirosis and Q Fever.

- **foxes** (European Red) (*Vulpes vulpes*)
  - the fox has played a major role in the decline of ground-nesting birds, small to medium sized mammals and reptiles. It is thought to have caused a severe reduction in populations of many threatened species. The fox causes significant economic losses to farmers by preying on newborn lambs, goat kids and poultry. The fox could also act as a carrier of rabies, should the disease accidentally be introduced into Australia. Rabies mostly affects members of the dog family, but can also be passed on to humans, livestock and native mammals (Australian Government 2004c).

- **a number of locust species** (the Australian Plague, Spur-Throated and Migratory locusts)
  - serious infestations of plague locusts cause significant economic loss to affected landholders.

Under the *Local Land Services Act 2013* all land managers in NSW, whether on public or private land, have an obligation to control declared pest species on their land. Coordinated pest control, where neighbours cooperate on a regional scale, is much more effective than landholders undertaking pest control alone.
5.7 Weeds

A weed is a plant growing where it is not wanted. A plant that is considered a weed in one situation may not be considered a weed in other contexts. Weeds are generally unwanted in a particular situation because they threaten agricultural productivity, have detrimental effects on the natural environment or impact on human health. Weeds reduce farm productivity, displace native species and contribute to ongoing land degradation and reduced land values (Northern Inland Weeds Advisory Committee 2009). Weeds are often classed into broad groups depending on their characteristics, impact and the situation in which they grow:

- noxious weeds
- weeds of national significance
- water weeds
- other weeds

Many weeds can be classed in more than one of these groups. For example, blackberry can be classed as a noxious weed, an environmental weed and an agricultural weed, depending on the situation where it is occurring. It is also listed as one of Australia’s Weeds of National Significance. Some cultivars are also grown for commercial blackberry production or in domestic gardens for berry harvest.

5.7.1 Weed Considerations at Glen Innes Agricultural Research and Advisory Station

Local weeds that potentially threaten the environmental and production values of Glen Innes Agricultural Research and Advisory Station include:

- Chilean needle grass (*Nassella neesiana*)
- African lovegrass (*Eragrostis curvula*).
- Hawthorn (*Crataegus monogyna*)
- Sweet briar (*Rosa rubiginosa*)
- Blackberry (*Rubus fruticosus* species aggregate)
- Nodding thistle (*Carduus nutans* subsp. *nutans*)
- Scotch thistle (*Onopordum acanthium*)

5.8 Emergency Issues

The property may at times be threatened by emergencies such as bushfires, floods, extended drought and storm damage. A plan to mitigate the main risks should be recommended to the property owner. Every business or property needs an effective response plan for dealing with emergencies. In any emergency, such as a fire, flood or storm, a response plan can help to minimise loss of life, injury, property damage and costly disruption to business operations.

5.9 Key Points

*Consider the biosecurity risks that might threaten the environmental and production values of Glen Innes Agricultural Research and Advisory Station. What measures can be put in place to mitigate these risks? Compare the costs of putting in place measures to reduce biosecurity risks with the loss of production and remedial costs of fixing a major biosecurity issue.*

The farm biosecurity toolkit is a great resource to find additional biosecurity information:

6.  CULTURAL HERITAGE

6.1 Aboriginal Cultural Heritage

Aboriginal people have lived in NSW for more than 40,000 years. There's evidence of this everywhere, in rock art, stone artefacts and other sites across the state. But if you thought Aboriginal heritage was just about rock art, think again. Aboriginal culture is much bigger than this and it's a living, ongoing thing. It's deeply linked to our entire environment - plants, animals and landscapes.

The land and waterways are associated with dreaming stories and cultural learning that is still passed on today. It is this cultural learning that links Aboriginal people with who they are and where they belong. To protect Aboriginal heritage, we can't just look after sites in parks or artefacts in museums. Aboriginal people need to be able to access land to renew their cultural learning and they have to be involved and consulted in the conservation of our natural environment.

Around Glen Innes is the traditional territory of the Ngoorabul people. The Northern Tablelands region is rich in heritage, some examples include:

- artefact scatters and rock art
- burial sites
- scarred and carved trees
- grinding grooves and middens
- mission and reserve sites
- Aboriginal ceremony and dreaming sites
- Aboriginal resource and gathering sites
- ceremonial rings
- earth mounds
- ochre quarries
- potential archaeological deposits
- fish traps
- habitation structures
- hearths
- non-human bone or organic material
- shell middens
- stone arrangements
- modified trees
- water holes and
- stone quarries

Important Aboriginal sites near the Station include The Willows Boorabee Indigenous Protected Area (IPA), which is Aboriginal-owned land, managed for the conservation of its environmental and cultural values. The IPA is home to many iconic and threatened species such as the Koala, Spotted-tailed quoll, Murray cod and the endangered ecological community Box-gum grassy woodland.
6.2 Preserving Aboriginal Cultural Heritage on Private Property

Both pre-European and post-settlement sites and objects hold special meaning for Aboriginal and non-Aboriginal people. Preservation of these sites and objects is important for mutual understanding of Aboriginal culture.

Landholders and land managers are in the unique position of being able to look after significant parts of the history of this wonderful country. They can make a direct contribution to the preservation of its Aboriginal cultural heritage. Having Aboriginal sites on a property will not affect ownership.

If an Aboriginal site or object is discovered, this process should be followed:

**Step 1**: do not disturb the site or remove any artefacts or objects

**Step 2**: make a record of the site or object by taking photographs, recording the position and write a brief description of the find

**Step 3**: report the find to the appropriate Local Aboriginal Land Council

To preserve Aboriginal cultural heritage on a property, it is recommended to assess the site prior to any development or change of land use. Through a simple assessment process, landholders can determine whether the planned development or land use is likely to damage or destroy any items of importance before the development or change begins. There is a *Due Diligence Code of Practice for the protection of Aboriginal objects* which assists landholders. More information can be found in the brochure *Looking after our Aboriginal Cultural Heritage* (Northern Tablelands Local Land Services 2015).

After reporting an Aboriginal site or object, a Local Aboriginal Land Council representative can:

- Arrange a visit to the site where appropriate, to examine and confirm the findings
- Arrange formal recording through the Aboriginal Heritage Information Management System if the find is substantiated and of significance
- Help the landholder to secure the site to prevent erosion or any possible degradation until a formal agreement between the landholder and the Office of Environment and Heritage has been reached for managing the site.
7. FARM BUSINESS PLANNING

7.1 Farm Business Enterprises
Part of a farmer’s role as a decision maker is to decide which enterprises suit his/her land and his/her financial, environmental and lifestyle goals. On Glen Innes Agricultural Research and Advisory Station, the current livestock enterprises include a cattle breeding herd (consisting of Angus cows and calves, replacement females, bulls and steers), a flock of merino wethers and a cross-bred ewe flock. There are a number of research and/or fodder crops on the station, including oats, maize, red clover and brassicas, as well as improved pastures. Other enterprises and sources of income could potentially suit the land whilst maintaining the goal of profitability and sustainable use of resources. Some of the factors that farmers take into account when choosing an enterprise include potential profit, labour requirements, overheads, farm design, water availability and environmental impact.

7.2 Financial Information for Farm Decision Making

7.2.1 Gross Margin Budgets
One of the tools that farmers use to decide on enterprises is to calculate the gross margin of an enterprise. A ‘gross margin’ is the gross income from an enterprise, less the variable costs incurred in achieving it. It does not include fixed or overhead costs such as depreciation, interest payments, rates or permanent labour. Variable costs are those costs directly attributable to an enterprise and which vary in proportion to the size of an enterprise.

For example:

- If the area of wheat or sorghum sown doubles, then the variable costs associated with growing it, such as seed, chemicals and fertilisers, will roughly double.
- If the number of breeding cows doubles, then the variable costs associated with carrying the additional stock, such as drench and vaccination costs, will also roughly double.

The gross margin budgets are intended to provide a guide to the relative profitability of similar enterprises and an indication of management operations involved in different enterprises. A gross margin is not profit because it does not include fixed or overhead costs such as depreciation, interest payments, rates and permanent labour, which have to be met regardless of enterprise size.

Gross margins are generally quoted per unit of the most limiting resource, for example, land, labour, capital or irrigation water. Crop gross margins are provided on a per hectare basis and also per megalitre of water in the case of irrigated crops. It is also common for livestock gross margins to be quoted on a per dry sheep equivalent (DSE) basis reflecting returns on the grazing resource.
The livestock budgets express outcomes in terms of:

- gross margin per animal e.g. per breeding cow/ewe or per steer/wether;
- gross margin per hectare; and
- gross margin per DSE (dry sheep equivalent).

7.2.2 Cash Flow Budgets

Farmers utilise cash flow budgets to provide a detailed estimate of all the income and the expenses coming into and going out of the business. A cash flow budget helps a farmer to work out if they have enough cash to meet their financial commitments in a timely manner. Preparing a cash flow budget is an essential part of farm business management as it assists the farmer to make informed business decisions.

7.2.3 Key Point

To enable the farmer to evaluate the recommendations provided in your report it is essential that you provide estimates of income from suggested enterprises and accurate costings for your recommendations. The farmer can then use these estimates in their gross margins and cash flow budgets and make informed decisions about the recommendations provided.

7.3 Glen Innes Agricultural Research and Advisory Station Current Enterprises

Glen Innes Agricultural Research and Advisory Station covers a total area of 450ha, with an average season carrying capacity of 5,127 Dry Sheep Equivalent (DSE). This is an average stocking rate of 11.4 DSE/ha.
7.4 Pasture Management

7.4.1 Pasture Composition

The pastures throughout the property have been improved and comprise grasses such as phalaris, fescue, rye, cocksfoot, paspalum, rats tail grass, red grass, broad leaf weeds, red and white clover.

The quantity and quality of feed available on your farm impacts on your profit, livestock condition/wellbeing and the condition of your land. A diverse pasture is more resistant to the impact of drought. Pastures are usually composed of a range of different plant species which can include exotic (introduced) grass, naturalised grass, native grass, legume or weed. Different plants dominate the pasture during different seasons e.g. summer vs winter dominant species and some plants are annuals while other are perennials. Annuals are plants that perform their entire life cycle from seed to flower to seed within a single growing season. All roots, stems and leaves of the plant die annually. Only the dormant seed bridges the gap between one generation and the next. Perennials are plants that persist for many growing seasons. Different pasture species have various levels of palatability and growth and perform various functions in the ecosystem. For example, legumes (e.g. white clover, lucerne) are important nitrogen fixers which make nitrogen more available to other plants.

Higher quality feed is easier to digest by stock, meaning that their digestive systems do not need to use as much energy to break down food. Stock on quality pasture can convert this feed to meat faster than stock on lower quality pasture. Cattle on high quality feed do not produce as much methane as cattle on lower quality feed. Methane has been found to have an impact on greenhouse gas emissions and climate change.

Native pastures and their management are critical for enterprises on the Northern Tablelands. They are accustomed to Australian conditions and help to maintain native biodiversity. They are responsive to rainfall events, and tend to be more resilient in the extremes of the Australian climate. Many introduced species are harder to maintain given the conditions mentioned above. Some introduced species can become invasive (e.g. African lovegrass and Coolatai grass) overtaking large portions of agricultural lands, making it increasingly difficult and expensive for farmers to maintain their properties and their production. Other introduced pastures can be planted to increase production such as tropical and temperate pastures.

Quantity of pasture is very important. Farmers must budget their feed and monitor stocking rates to ensure that their pastures remain healthy and resilient so that they can survive during the cold winter when growth slows whilst being ready to prosper during the growing season in spring and summer.

7.4.2 Groundcover

Managing pastures to maintain adequate levels of groundcover is the most effective way to minimise run-off and erosion. By reducing run-off, more water is made available for plant growth. By reducing erosion, soil, nutrients and organic matter are retained in place and siltation problems are minimised. In addition, groundcover is important for soil health and assists in weed control. Groundcover is defined as any material on or near the soil surface that protects the soil against the erosive action of raindrops and overland flow. Per cent groundcover is the converse of per cent bare ground. Plant material, either alive or dead, is the most common and most important form of groundcover. Other materials
such as loose surface stones, dung and snow can also provide an effective groundcover (Lang & McDonald 2005). It is recommended that a minimum of 80 - 100% groundcover is achieved for most or all of the time to prevent degradation such as erosion.
7.4.3 Common Pasture Plants at Glen Innes Agricultural Research and Advisory Station

Red clover flower

White clover leaf (Photo: A. Sendall)

Paspalum

Tall fescue

Phalaris

Cock’s foot

Rye grass
8. DEVELOPING THE FARM PLAN

8.1 Land Use Hazards
Existing issues within the property will influence the final plan. What remedial action will be required? What enterprises and management strategies are most suited to these areas?

Table 6: Land Use Hazards that exist within the Competition Property

<table>
<thead>
<tr>
<th>Land Use Issues</th>
<th>Points to be aware of when developing management options</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tree decline</td>
<td>• Several areas of the property have a relatively low tree cover % because of past clearing, loss of trees due to dieback, grazing, and competition from pastures.</td>
</tr>
<tr>
<td></td>
<td>• Tree decline can reduce agricultural production through loss of shade and shelter, as well as contributing to other forms of land degradation such as erosion, salinity and waterlogging.</td>
</tr>
<tr>
<td>Water quality</td>
<td>• Stock access to some dams and watercourses means some waterways on the property experience high levels of turbidity (muddy water).</td>
</tr>
<tr>
<td>Invasive weed species</td>
<td>• Weeds are a land use issue. In particular, invasive perennial grass species including <em>Nassella neesiana</em> (Chilean needle grass) and <em>Eragrostis curvula</em> (African love grass).</td>
</tr>
<tr>
<td></td>
<td>• If allowed to persist in the pasture, these grass species seed profusely and have a tendency to grow to dominate the pasture composition. The lack of palatability of these grasses in particular lead to production declines in grazing stock.</td>
</tr>
<tr>
<td>Ground cover</td>
<td>• The percentage of ground cover influences water infiltration, erosion, potential weed invasion and feed quality and quantity.</td>
</tr>
</tbody>
</table>

8.2 Rainfall Use Efficiency
When rain falls there are four paths it may take – run off, deep drainage, transpiration or evaporation (see Table 7 below). There are a number of factors relating to the physical landscape and to management that influence what happens to rain that falls on the property.

Property management plans should aim to make the most of rainfall, that is, increase the rainfall use efficiency, reducing losses from run off, deep drainage and evaporation.
### Table 7: Rainfall can go to the following places when it falls

<table>
<thead>
<tr>
<th>Component</th>
<th>Description</th>
<th>% of total rainfall</th>
</tr>
</thead>
<tbody>
<tr>
<td>Run off</td>
<td>The amount of rainfall that runs off is determined by slope, groundcover, soil structure and depth to any impermeable layers in the soil profile.</td>
<td>Low 4%</td>
</tr>
<tr>
<td></td>
<td>• The steeper the slope, the easier it is for water to run</td>
<td>Common 10%</td>
</tr>
<tr>
<td></td>
<td>• Less than 70% groundcover makes it easier for water to run</td>
<td>High 15%+</td>
</tr>
<tr>
<td></td>
<td>• Soils with poor structure have low infiltration rates and run water more easily</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Shallow soils fill quickly and the balance runs off</td>
<td></td>
</tr>
<tr>
<td>Deep Drainage</td>
<td>Deep drainage occurs when water that cannot be stored in the soil passes beyond the plant root zone. Soils with coarse texture have less capacity to retain water and drain more easily. Agronomic systems that rely on stored soil water also encourage deep drainage.</td>
<td>Average 2-4%</td>
</tr>
<tr>
<td>Evaporation/</td>
<td>Loss from bare earth, ineffective transpiration or losses due to soil nutrient status.</td>
<td>Low 15%</td>
</tr>
<tr>
<td>Inefficiency</td>
<td></td>
<td>High 6-8%</td>
</tr>
<tr>
<td>Transpiration</td>
<td>Amount of rainfall actually required to grow grass to feed animals, or to grow crops and to form a litter layer on the soil surface.</td>
<td>Balance</td>
</tr>
</tbody>
</table>

* See the figure on the following page for a pictorial representation of this table


#### 8.3.1 To Make the Most of Rain that Falls

Aim to maintain as much groundcover as possible with 12mm of litter to reduce evaporation and to maintain optimal soil temperature.

Maintain a minimum 80% groundcover (everything other than bare earth) at all times to reduce run off and erosion.
Figure 7: Rainfall uses
8.3 Legal Obligations

Many legal constraints affect the final property plan. Table 8 briefly outlines the current legal constraints and their implications for the property. The NSW Government introduced a new framework for land management and biodiversity conservation which commenced in August 2017. More information can be found at relevant websites.

### Table 8: Legal constraints within the Competition Property

<table>
<thead>
<tr>
<th>Issue</th>
<th>Legal constraint</th>
</tr>
</thead>
<tbody>
<tr>
<td>Native Vegetation Clearing</td>
<td><strong>Local Land Services Act 2013</strong>  &lt;br&gt;The new laws make provisions for a Native Vegetation Regulatory Map that will indicate rural land where:  &lt;br&gt;- Native vegetation clearing can occur without approval (non-regulated)  &lt;br&gt;- Landholders need to comply with the Local Land Services Amendment Act 2016 (regulated)  &lt;br&gt;- Native vegetation may be managed on regulated land via the use of Codes of Practice and Allowable Activities.  &lt;br&gt;<a href="https://www.landmanagement.nsw.gov.au/">https://www.landmanagement.nsw.gov.au/</a></td>
</tr>
<tr>
<td>Protected land</td>
<td><strong>Soil Conservation Act 1938</strong>  &lt;br&gt;This applies to stream banks (no native vegetation removal within 20 metres of stream bank). Also applies to lands that are steep, greater than 33 % / 18 degrees. Existing native vegetation must be retained and allowed to regenerate. This includes grasses as well as shrubs and trees.</td>
</tr>
<tr>
<td>Noxious weeds, biosecurity issues</td>
<td><strong>Biosecurity Act 2015</strong>  &lt;br&gt;The Biosecurity Act provides the framework to protect our community from the adverse effects from animal and plant pests, diseases and weeds to maintain market access. The Biosecurity Act will also help protect our environment from invasive pests and diseases allowing the continued enjoyment of our lifestyle.  &lt;br&gt;<a href="https://www.dpi.nsw.gov.au/biosecurity/biosecurity-legislation/bio-leg-other/key-questions-and-answers">https://www.dpi.nsw.gov.au/biosecurity/biosecurity-legislation/bio-leg-other/key-questions-and-answers</a></td>
</tr>
<tr>
<td>Local Government Planning Zones</td>
<td>Rural Zone  &lt;br&gt;Generally encourages rural pursuits within this zone, and incompatible development should be controlled.</td>
</tr>
<tr>
<td>Water – farm dams and groundwater</td>
<td><strong>Water Management Act 2000</strong>  &lt;br&gt;Under the Water Reform legislation up to 10% of the water that falls on the property may be harvested (stored in a dam) and used for any purpose before a licence must be obtained. This is called the harvestable right. This guarantees a basic level of access to a water supply for the rural community.  &lt;br&gt;For more information go to:  &lt;br&gt;<a href="https://www.water.nsw.gov.au/water-licensing">https://www.water.nsw.gov.au/water-licensing</a></td>
</tr>
</tbody>
</table>
8.4 Making Decisions on Land Use

The important part of this plan is to determine the broad area land management practices for land within the property. The management recommendations should take into account all the resource information provided, address the Land Use Hazards outlined in Table 6, and consider the legal constraints given in Table 8. If legal obligations affect your recommendations then you need to cover this and be specific.

8.4.1 Using Land Management Units

Land use is going to be different across the property. Land management can be defined by delineating paddock units. The boundary and size of each management unit has to be decided based on the information provided in your maps and from the information in this resource book. Land management units are best shown as shaded areas, or using a numbered system on the property map with a summarised legend.

Land management issues that should be considered over the whole or parts of the property may include:

- enterprise selection e.g. grazing sheep or cattle
- soil management
- weed and vermin control
- fire prevention and control
- drought management
- management of riparian areas
- protection of environmentally sensitive lands
- use of land within its capability
- tree and native vegetation management

8.4.2 Key Points

Consider long term issues such as fossil fuels, global warming and climate change. What risks might these impose on farming operations? How can these be best managed?

Effective property planning occurs over a long period of time. Don’t plan all of your changes for tomorrow. Prioritise the most valuable things to get done first, but also provide “vision” for future priorities.
8.5 Monitoring

Once a property plan is developed monitoring becomes essential. There is no system or practice that applies everywhere and gives uniform results and there are a number of variables interacting in the farming system to consider. Monitoring practices enable the landholder to evaluate the effectiveness of the changes they choose to implement in their farming system, provides an early warning system if there are weaknesses in the plan and helps reduce risk and uncertainty regarding implementation of the plan.

Suggested monitoring practices should be considered carefully and kept simple to make it more achievable for the landholder to carry these out. You can select a number of sites in which they can do regular monitoring. The sites should either be representative of a large proportion of the property or have an obvious or suspected land degradation problem. Decide on some indicators of change that you can use to monitor changes on the property. Think about some of the tests and assessments you participated in at the field day. Some examples could include:

- Pasture and/or groundcover percentage
- Pasture and/or crop yields
- Soil carbon or structural changes and soil pH
- Records of bird sightings as an increase in the number and diversity of species signals better environmental conditions
- Water quality
- Production records
- Financial records

Mark the sites on your map and refer to them in your report.

An example of a monitoring tool you could use is the GroundCover App which is a free App for iPhone and Android devices. It was developed to provide graziers with a tool to measure groundcover across their paddocks using the step point method. You will measure the percentage of pasture and other material that is covering the soil surface when looking down on it. Monitoring pastures using an objective tool such as Ground Cover provides a valuable benchmark for managing paddocks and pastures across the property.
8.6 The Plan and Report

8.6.1 The Physical Plan

Once you have considered the information and issues, the next step is to draw up your property plan. Download and print the boundary map then draw directly onto the page. The north arrow, scale and boundary are already marked so all you need to do is draw on your plan. Standard mapping symbols used in property planning are given below but you are not limited to using these symbols as long as you label and include a legend.

8.6.2 How to Map

A good tip when drawing your plan is to use standard mapping colours i.e. blue for water, brown for earthworks, green for vegetation. Using shading or hatching over an area can show what the plan is for that area i.e. changing the land use for that paddock.

Table 9: Suggested symbols to be used on your map

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="Symbol" /></td>
<td>Dam</td>
</tr>
<tr>
<td><img src="image2" alt="Symbol" /></td>
<td>Contour</td>
</tr>
<tr>
<td><img src="image3" alt="Symbol" /></td>
<td>Yards</td>
</tr>
<tr>
<td><img src="image4" alt="Symbol" /></td>
<td>Waterway</td>
</tr>
<tr>
<td><img src="image5" alt="Symbol" /></td>
<td>Windmill</td>
</tr>
<tr>
<td><img src="image6" alt="Symbol" /></td>
<td>Tree regeneration area</td>
</tr>
<tr>
<td><img src="image7" alt="Symbol" /></td>
<td>Tank</td>
</tr>
<tr>
<td><img src="image8" alt="Symbol" /></td>
<td>Windbreak</td>
</tr>
<tr>
<td><img src="image9" alt="Symbol" /></td>
<td>Watering point</td>
</tr>
<tr>
<td><img src="image10" alt="Symbol" /></td>
<td>Tree lot</td>
</tr>
</tbody>
</table>
8.6.2.1 Mapping land use

Using an aerial view of your property, the Land Class table and field checking, identify the most limiting factor for each parcel of land on your property. Consider the nature of any ‘problem areas’ on your farm. These can indicate whether the land has been used beyond its capability in the past. The most limiting factor determines the capability of the area.

In the example below, boundaries between different land classes are drawn and numbered in green and soils have been marked in yellow.

8.6.2.2 Your Ideal Farm Layout

Revisit your assessment of farm infrastructure and review and update your improvement strategies for your farm plan by drawing these on your map and noting them in your farm plan.

Fences:
- Plan fencing to achieve as many outcomes as possible
- Fencing to facilitate grazing management
- Cost effectiveness and the best design for least cost
- Planning relocation at time of replacement
- Placement in relation to water courses, watering points and to avoid damage from floods
- Placing fences on contours or on land capability boundaries
- Fencing to soil type
- Fencing degraded areas
- Location of gates on well drained areas

Laneways:
- Width to enable vehicle access
- Stable ground
- Watering points so they can be grazed
- Strategic placement of gates
- Shelter
- Accessing as many paddocks as possible
- Can your laneway serve multiple purposes? E.g. firebreak?

**Roads and Access:**

- Avoiding crossing on waterways if possible
- Locating tracks along ridgelines or contours
- Erosion protection
- Contours and slope

**Stock Yards:**

- Placement close to centre of property
- Placement close to laneway for ease of access
- Is a set of loading yards useful at front of property to improve truck access?
- Drainage and direction of runoff away from yards
- Providing shade and shelter

**Water supply:**

- How to best provide good quality, clean, reliable water
- Potential dam, tank, trough and bore sites
- How to place water to facilitate good grazing management

For cleaner water you can consider (Brouwer, 2012):

- Filter zones for dams. A well grassed filter zone where water runs into dams to filter out material such as silt, fertiliser, manure, dead vegetation, litter and rubbish will improve water quality in dams.
- Restricted stock access to farm dams. Fencing dams and leaving a small area of the dam open for stock access can improve water quality.
- Buffer zones along creeks and rivers. Fencing sections of creeks and rivers enables revegetation and stabilisation. Buffer zones of 5 – 100m are recommended. Generally 20 – 30 metres is best.
- Fencing dams and piping water from them to troughs. This improves water quality and encourages vegetation regeneration around the dam.

**Considerations for location of water infrastructure (Brouwer, 2012):**

- Stock access. Continual tracking from one direction can lead to soil erosion and possible siltation of the storage
- Large paddocks may be more evenly grazed by providing more watering points. If you can provide water, smaller paddocks will improve grazing management.
- Distance stock need to walk for water. Travelling long distances for water will increase the energy required and can result in lost production.
- A permanent pipeline with transportable troughs to provide improved grazing management and allow options for managed grazing.
• Ensure flow rate and capacity of pipes and troughs meet peak water demands in summer.
• Can you turn off water in unused paddocks to minimise the attraction of additional grazing pressure from feral animals and kangaroos?

Tree planting:
• Consider planting trees for windbreaks, woodlots, shade & wildlife habitat
• Utilising higher points in the landscape increases the effective area of wind protection from windbreaks. Plantings on upper slopes and ridgelines provide maximum wind protection.
• Plantings on lower slopes will shelter livestock, crops and pastures
• Avoid planting shelter belts up and down hills if there is potential for erosion from channelled water
• Place shelter plantings across the direction of damaging hot and cold winds and along contours
• Contain a mixture of species, trees and shrubs and a range of ages. Include plantings of local plants that flower at different times of the year to attract predatory birds and insects.
• Plant shelter belts where they can link together and with existing remnant vegetation and woodlots to provide additional food, shelter & movement corridors for wildlife.

Design shelter belts so that they (Brouwer, 2012):
• Are approximately 20 times the height of trees in the belt from the distance to the next shelter belt
• Are wider than the height of trees in the belt
• Are longer than 20 times the height of trees in the belt
• Have porosity of approximately 50% from ground to top of canopy (so some light can be seen through foliage)
• Consist of at least three rows of trees and shrubs

Remnant vegetation management:
• Retain existing clumps of remnant vegetation
• Connect vegetation into corridors
• Have some larger remnants
• Consider prevailing winds
• Smaller paddocks and managed grazing can reduce pressure and encourage natural regeneration of paddock trees
• Consider fencing off areas of remnant vegetation to control livestock access
• Consider fencing areas around mature trees to encourage natural regeneration
• Retain where possible, fallen and standing dead timber, rocks, logs and stumps for wildlife habitat

Infrastructure:
• Buildings, sheds, silos
• Existing infrastructure can be relocated and eventually will need to be replaced.

Consider options for solving problems. Problem areas can include:
• Soil erosion
- Dryland salinity
- Access points
- Weed infestations
- Pest animals (e.g. rabbit burrows)
- Lack of shelter
- Animal health issues (e.g. liver fluke)
- Inadequate water supply
- Problem soils (e.g. rocky, shallow soil)
- Bushfire risk
- Tree decline

8.6.3 The Report

You are allowed a maximum of 3500 words using standard page formatting for the report.

- Remember that land use, management and marketing proposals should be outlined in your report along with reasons for your decisions. List options then justify the recommended action.
- DO NOT use appendices to explain your report findings as they WILL NOT be read or marked.

A major part of property planning is evaluation of alternative enterprises for each particular management unit. This usually includes a comparison and assessment of the economic viability of the alternative enterprise as well as addressing physical requirements. However, for the purposes of this exercise it is not necessary to produce a detailed report on economic aspects. A simple summary is sufficient along with a short explanation of why a particular enterprise was recommended. Nevertheless, it is still important to consider how you would fund any specific works suggested.
9. FURTHER RESOURCES

9.1 Expertise
There are many sources of information you can access for technical information. Below is a list to get you started:

- NSW Office of Environment and Heritage
- NSW Department of Primary Industries
- Northern Tablelands Local Land Services
- Commercial agronomists
- Your local library, school resources and the internet

9.2 Funding Opportunities
Think about whether works and management changes you are considering are able to be funded through external means. Environmental works that have public benefit (in addition to benefits to the landholder) may be able to be supported financially through different organisations. The following sources of information may be useful:


9.3 Other Relevant Organisations and Websites

<table>
<thead>
<tr>
<th>Table 10: Useful contacts</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>NSW Departments and Organisations:</strong></td>
<td></td>
</tr>
<tr>
<td>Landcare NSW</td>
<td><a href="http://www.landcarensw.org.au">www.landcarensw.org.au</a></td>
</tr>
<tr>
<td><strong>National Departments and Organisations:</strong></td>
<td></td>
</tr>
<tr>
<td>Greeing Australia</td>
<td><a href="http://www.greeningaustralia.org.au">www.greeningaustralia.org.au</a></td>
</tr>
<tr>
<td>CSIRO</td>
<td><a href="http://www.csiro.au">www.csiro.au</a></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Others:</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Landline ABC</td>
<td><a href="http://www.abc.net.au/landline">www.abc.net.au/landline</a></td>
</tr>
</tbody>
</table>
10. REFERENCES & FURTHER INFORMATION


Animal Health Australia (2012b) *Farm Biosecurity for Livestock Producers* Animal Health Australia, Australia

Australian Government (2004a) *European wild rabbit (Oryctolagus cuniculus)* Australian Government Canberra ACT

Australian Government (2004b) *The Feral Pig (Sus scrofa)* Australian Government Canberra ACT

Australian Government (2004c) *European Red Fox (Vulpes vulpes)* Australian Government Canberra ACT


Brouwer (2012) *Property Planning – Ag Guide*, State of NSW through Department of Primary Industries, NSW Australia


Elvins, C. (2017) *A Brief History of the Glen Innes Agricultural Research & Advisory Station*, Department of Primary Industries, Glen Innes NSW

Land, D. & W. McDonald (2005) *Maintaining groundcover to reduce erosion and sustain production Agfact P2.1.14*, The State of New South Wales Department of Primary Industries, NSW.

DPI (2018) *Glen Innes Agricultural Research and Advisory Station* Department of Primary Industries NSW, accessed 2/2/18.


McKemey, Michelle (2013) *Managing Native Vegetation: How to look after your native vegetation and revegetate your land* Border Rivers Gwydir Catchment Management Authority Inverell NSW

McKemey, Michelle and Harry White (2011) *Bush Tucker, Boomerangs and Bandages: Traditional Aboriginal Plant Use in the Border Rivers and Gwydir Catchments* Border Rivers Gwydir Catchment Management Authority, Inverell NSW

Miles C., Lockwood M., Walpole S. and E. Buckley (1998) *Assessment of the on-farm economic values of remnant native vegetation.* Charles Sturt University, Johnstone Centre of Parks, Recreation & Heritage, Albury NSW


Plant and Seaman (2007a) *Ovine brucellosis* Department of Primary Industries NSW, accessed 10/2/16


Plant & Seaman (2007b) *Vibriosis of cattle* Department of Primary Industries NSW, accessed 10/2/16


Walker (2007) *Pinkeye in cattle* Department of Primary Industries NSW, accessed 10/2/16


Walker & McKinnon 2011 *Bovine Trichomoniasis* State of New South Wales through Department of Trade and Investment, Regional Infrastructure and Services, accessed 10/2/16


Zelski (2007) *Leptospirosis in cattle herds* Department of Primary Industries NSW, accessed 10/2/16

11. GLOSSARY

Catchment: The area of land drained by a river and its tributaries.

Contour: An imaginary line on the surface of the earth connecting points of the same elevation.

Contour bank: A bank which is constructed along the contour and graded to discharge water at either or both ends depending on requirements.

Discharge area: An area in which groundwater is discharged at the ground surface. Discharge can occur via springs, seepage or through capillary rise and evaporation.

Dispersion: If a soil disperses (example pictured on right), it is likely to erode and is likely to have high exchangeable sodium.

Drainage line: A channel down which surface water naturally concentrates and flows, conveying water only during and/or immediately following periods of heavy rainfall.

Footslope: A moderate to very gently sloping landform at the lower end of a slope.

Hillslope: A gently inclined to precipitous landform usually comprising side slopes and foot slopes.

Organic matter: That fraction of the soil including plant and animal residues at various stages of decomposition, cells and tissues of soil organism, and substances synthesised by them. Is a major source of plant nutrients and substances which assist in soil structure maintenance.

Outcrop: The exposure at the surface of rock that is inferred to be continuous with the underlying bedrock.

Recharge area: Where water can enter the soil and move downward to the groundwater. Recharge is greater in rocky areas and in soils which are highly permeable.

Rill erosion: The removal of soil by run-off from the land surface whereby numerous small channels, generally up to 30cm deep, are formed. Typically occurs on recently disturbed soils.

Run-off: That portion of precipitation not immediately absorbed into or detained upon the soil and which thus becomes surface flow. The amount of run-off depends on rainfall intensity and duration, land slope, surface roughness, vegetative cover and surface soil conditions including moisture content.

Scald: A bare area produced by the removal of the surface soil by wind and/or water erosion. The result is exposure of the more clayey subsoil which is, or becomes, relatively impermeable to water. The term is also used for a bare surface area caused by salting.

Sheet Erosion: The removal of a fairly uniform layer of soil from the land surface by raindrop splash and/or run-off. No perceptible channels are formed.
Shelterbelt: An area of living trees and/or shrubs established and maintained for the protection of grazing animals from climatic conditions. Shelterbelts may also act as windbreaks.

Slope: A landform which is neither a crest nor a depression and that has an inclination greater than one percent.

Slaking: If slaking occurs (example pictured on right) it is caused by trapped air being forced out and a lack of organic matter. If slaking occurs very quickly, the soil is very low in organic matter. If this occurs at the surface it can block surface pores, it is more likely to erode and form crusts on the surface.

Stream bank erosion: The removal of soil from stream banks by the direct action of stream flow, and/or wind/wave action. This typically occurs during periods of high flow.

Topographic map: A map which indicates both the horizontal and vertical relationship of the feature represented.

Topography: The shape of the ground surface as depicted by the presence of hills, mountains or plains.

Topsoil: That part of the soil profile, typically the $A_1$ horizon, containing material which is usually more fertile and better structured than underlying layers. Topsoil is the most important part of the soil with respect to the growth of crops or pastures and its loss or degradation represents the most serious aspect of soil erosion.

Water erosion: An erosion process in which soil is detached and transported from the land by the action of rainfall, run-off, and/or seepage.

Water table: The upper surface of groundwater below which the pores of rock or soil are saturated.

Wind erosion: An erosion process in which soil is detached and transported from the land surface by the action of wind. Where the removal of a fairly uniform layer of soil from the land surface occurs the term sheet erosion may be used.

Windbreak: A barrier of living trees and/or shrubs or other materials which reduces the velocity of the wind near the soil surface, thus protecting the soil from wind erosion.
12. **APPENDIX 1 – Maps**

12.1 **Map 1 ‘Glen Innes Agricultural Research and Advisory Station Infrastructure’**

(Includes all infrastructure and biophysical information)
12.2 Map 2 ‘Glen Innes Agricultural Research and Advisory Station Rural Land Capability’
(Displayed the rural land capability classes of the property)
12.3 Map 3 ‘Glen Innes Agricultural Research and Advisory Station Biodiversity’
(Displays the remnant vegetation, water catchments and provides a landscape context to the property)
12.4 Map 4 ‘Glen Innes Agricultural Research and Advisory Station - Student Map’
(Blank map for development of property plan)
# 13. APPENDIX 2 - Vegetation Species List

Common flora found on and around Glen Innes Agricultural Research and Advisory Station (including planted tree lines)

<table>
<thead>
<tr>
<th>Botanical Name</th>
<th>Common Name</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Trees</strong></td>
<td></td>
</tr>
<tr>
<td>Eucalyptus dalympleana subsp. heptantha</td>
<td>Mountain gum</td>
</tr>
<tr>
<td>Eucalyptus nova-anglica</td>
<td>New England peppermint</td>
</tr>
<tr>
<td>Eucalyptus pauciflora</td>
<td>Snow gum</td>
</tr>
<tr>
<td>Eucalyptus rubida</td>
<td>Candlebark</td>
</tr>
<tr>
<td>Eucalyptus viminalis</td>
<td>Ribbon gum</td>
</tr>
<tr>
<td>Eucalyptus blakelyi</td>
<td>Blakely's red gum</td>
</tr>
<tr>
<td>Eucalyptus stellulata</td>
<td>Black sallee</td>
</tr>
<tr>
<td>Eucalyptus melliodora</td>
<td>Yellow box</td>
</tr>
<tr>
<td>Eucalyptus acaciaiformis</td>
<td>Wattle leaved peppermint</td>
</tr>
<tr>
<td>Eucalyptus crenulata</td>
<td>Silver gum</td>
</tr>
<tr>
<td>Angophora floribunda</td>
<td>Rough barked apple</td>
</tr>
<tr>
<td><strong>Shrubs</strong></td>
<td></td>
</tr>
<tr>
<td>Acacia floribunda*</td>
<td>White Salllee wattle</td>
</tr>
<tr>
<td>Acacia baileyana*</td>
<td>Cootamundra wattle</td>
</tr>
<tr>
<td>Callistemon sp.</td>
<td>Bottlebrush</td>
</tr>
<tr>
<td><strong>Groundcovers</strong></td>
<td></td>
</tr>
<tr>
<td>Themeda australis</td>
<td>Kangaroo grass</td>
</tr>
<tr>
<td>Bothriochloa macra</td>
<td>Red grass</td>
</tr>
<tr>
<td>Sporobolus creber</td>
<td>Slender Rat's Tail grass</td>
</tr>
<tr>
<td>Poa sieberiana</td>
<td>Snow grass</td>
</tr>
<tr>
<td>Paspalum dilatatum*</td>
<td>Paspalum</td>
</tr>
<tr>
<td>Festuca arundinacea*</td>
<td>Tall fescue</td>
</tr>
<tr>
<td>Lolium perenne*</td>
<td>Rye grass</td>
</tr>
<tr>
<td>Phalaris aquatic*</td>
<td>Phalaris</td>
</tr>
<tr>
<td>Dactylis glomerata*</td>
<td>Cocksfoot</td>
</tr>
<tr>
<td>Trifolium pratense*</td>
<td>Red clover</td>
</tr>
<tr>
<td>Trifolium repens*</td>
<td>White clover</td>
</tr>
<tr>
<td>Nassella neesiana*</td>
<td>Chilean needle grass</td>
</tr>
<tr>
<td>Eragrostis curvula*</td>
<td>African lovegrass</td>
</tr>
<tr>
<td><strong>Other plants</strong></td>
<td></td>
</tr>
<tr>
<td>Amyema sp.</td>
<td>Mistletoe</td>
</tr>
</tbody>
</table>

^ denotes threatened species  * denotes exotic species  ^ denotes planted species not endemic to area
## 14. APPENDIX 3 - Fauna Species List

Common fauna found on and around Glen Innes Agricultural Research and Advisory Station

### Birds

<table>
<thead>
<tr>
<th>Species</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australian raven</td>
</tr>
<tr>
<td>Black duck</td>
</tr>
<tr>
<td>Black-faced cuckoo-shrike</td>
</tr>
<tr>
<td>Black swan</td>
</tr>
<tr>
<td>Blue-faced honeyeater</td>
</tr>
<tr>
<td>Brown falcon</td>
</tr>
<tr>
<td>Brown honeyeater</td>
</tr>
<tr>
<td>Brown songlark</td>
</tr>
<tr>
<td>Brown thornbill</td>
</tr>
<tr>
<td>Brown quail</td>
</tr>
<tr>
<td>Corella</td>
</tr>
<tr>
<td>Crested pigeon</td>
</tr>
<tr>
<td>Crimson rosella</td>
</tr>
<tr>
<td>Crimson robin</td>
</tr>
<tr>
<td>Eastern rosetta</td>
</tr>
<tr>
<td>Eastern spinebill</td>
</tr>
<tr>
<td>Forest raven</td>
</tr>
<tr>
<td>Fuscous honeyeater</td>
</tr>
<tr>
<td>Galah</td>
</tr>
<tr>
<td>Golden whistler</td>
</tr>
<tr>
<td>Grey butcherbird</td>
</tr>
<tr>
<td>Grey fantail</td>
</tr>
<tr>
<td>Grey teal</td>
</tr>
<tr>
<td>House sparrow*</td>
</tr>
<tr>
<td>Indian myna bird*</td>
</tr>
<tr>
<td>Jacky winter</td>
</tr>
<tr>
<td>King parrot</td>
</tr>
<tr>
<td>Kookaburra</td>
</tr>
<tr>
<td>Little friarbird</td>
</tr>
<tr>
<td>Magpie</td>
</tr>
<tr>
<td>Nankeen kestrel</td>
</tr>
<tr>
<td>Noisy friar bird</td>
</tr>
<tr>
<td>Noisy miner</td>
</tr>
<tr>
<td>Pacific heron</td>
</tr>
<tr>
<td>Peaceful dove</td>
</tr>
<tr>
<td>Pee-wee</td>
</tr>
<tr>
<td>Pied currawong</td>
</tr>
<tr>
<td>Red wattlebird</td>
</tr>
<tr>
<td>Reed warbler</td>
</tr>
<tr>
<td>Richard’s pipit</td>
</tr>
<tr>
<td>Rufous whistler</td>
</tr>
<tr>
<td>Sacred kingfisher</td>
</tr>
<tr>
<td>Silveryeye</td>
</tr>
<tr>
<td>Spur-winged plover</td>
</tr>
<tr>
<td>Starling*</td>
</tr>
<tr>
<td>Straw-necked ibis</td>
</tr>
<tr>
<td>Striated thornbill</td>
</tr>
</tbody>
</table>

### Amphibians

<table>
<thead>
<tr>
<th>Species</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eastern banjo frog</td>
</tr>
<tr>
<td>Green tree frog</td>
</tr>
<tr>
<td>Striped marsh frog</td>
</tr>
</tbody>
</table>

### Mammals

<table>
<thead>
<tr>
<th>Species</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brown hare*</td>
</tr>
<tr>
<td>Brushtail possum</td>
</tr>
<tr>
<td>Eastern grey kangaroo</td>
</tr>
<tr>
<td>Fox*</td>
</tr>
<tr>
<td>Fruit bat</td>
</tr>
<tr>
<td>Koala*</td>
</tr>
<tr>
<td>Pretty-faced wallaby</td>
</tr>
<tr>
<td>Rabbit*</td>
</tr>
<tr>
<td>Ringtail possum</td>
</tr>
<tr>
<td>Short-beaked echidna</td>
</tr>
<tr>
<td>Sugar glider</td>
</tr>
<tr>
<td>Swamp wallaby</td>
</tr>
<tr>
<td>Various microbat species</td>
</tr>
<tr>
<td>Wallaroo</td>
</tr>
</tbody>
</table>

### Reptiles

<table>
<thead>
<tr>
<th>Species</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eastern bearded dragon</td>
</tr>
<tr>
<td>Eastern blue-tongue</td>
</tr>
<tr>
<td>Eastern brown snake</td>
</tr>
<tr>
<td>Eastern snake-necked turtle</td>
</tr>
<tr>
<td>Eastern water dragon</td>
</tr>
<tr>
<td>Highland copperhead</td>
</tr>
<tr>
<td>Pale-flecked garden sunskink</td>
</tr>
<tr>
<td>Red-bellied black snake</td>
</tr>
<tr>
<td>Tiger snake</td>
</tr>
</tbody>
</table>

### Invertebrates

<table>
<thead>
<tr>
<th>Species</th>
</tr>
</thead>
<tbody>
<tr>
<td>Freshwater yabby</td>
</tr>
</tbody>
</table>

* Indicates introduced species ^ threatened species
### APPENDIX 4: Marking schedule

<table>
<thead>
<tr>
<th>Criterion</th>
<th>High standard Mark: 6 - 8</th>
<th>Adequate standard Mark: 3 - 5</th>
<th>Not done Mark: 0</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Consideration of land capability, in use and management strategy</td>
<td>Thorough discussion of strategies</td>
<td>Adequate discussion addressing hazards and issues</td>
<td>No discussion of strategies</td>
</tr>
<tr>
<td>2. Issues and hazards addressed</td>
<td>Thorough discussion addressing hazards and issues</td>
<td>Inappropriate suggestions addressing hazards and issues</td>
<td>No discussion addressing hazards and issues</td>
</tr>
<tr>
<td>3. Enterprise selection and suitability, marketing options</td>
<td>Appropriate enterprise &amp; marketing selection &amp; relevant marketing explanation</td>
<td>Inappropriate or inappropriate enterprise selection &amp; marketing</td>
<td>No information presented to show enterprise selection &amp; marketing</td>
</tr>
<tr>
<td>4. Consideration of land manager's conditions</td>
<td>Some consideration given to all aims</td>
<td>Some consideration given to some aims</td>
<td>No consideration</td>
</tr>
<tr>
<td>5. Map presentation reflecting the plan</td>
<td>Map presented very clearly and to a high standard with presentation</td>
<td>Map presented clearly with some effort made with presentation</td>
<td>Not included, poor presentation</td>
</tr>
<tr>
<td>6. Report presentation of the plan</td>
<td>Report presented very clearly to a high standard with presentation</td>
<td>Report presented clearly with some effort made with presentation</td>
<td>Not included, poor presentation</td>
</tr>
<tr>
<td>7. Use of Resource Information Provided</td>
<td>Mostly resource information used to develop management recommendations and map</td>
<td>Some resource information used to develop management recommendations and map</td>
<td>No use of information provided</td>
</tr>
</tbody>
</table>

**Score**
- High standard: Mark 6 - 8
- Adequate standard: Mark 3 - 5
- Not done: Mark 0
## Marking Schedule – Schools Property Planning Competition 2018

<table>
<thead>
<tr>
<th>Criterion</th>
<th>Not done Mark: 0</th>
<th>Consideration given Marks: 1 - 2</th>
<th>Adequate standard Marks: 3 - 5</th>
<th>High standard Marks: 6 - 8</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>8. Legal Considerations accounted for.</td>
<td>No accounting for legal considerations.</td>
<td>Legal constraints considered, but unclear how they affected decisions</td>
<td>Legal constraints considered. Clearly affected management decisions</td>
<td>Legal issues clearly considered and applied to management, Consideration given to overcoming legal constraints.</td>
<td></td>
</tr>
<tr>
<td>9. Funding Considered</td>
<td>No consideration of funding works.</td>
<td>Mention of the need to source funding.</td>
<td>Funding sources suggested for works proposed.</td>
<td>Range of funding options explored and linked to proposed works.</td>
<td></td>
</tr>
<tr>
<td>10. Use of other resources</td>
<td>No reference to other resources used.</td>
<td>References given to use of resources, but irrelevant resources used.</td>
<td>References given to use of resources. Relevant resources used but not referenced.</td>
<td>List of relevant resources mentioned in text and references given.</td>
<td></td>
</tr>
<tr>
<td>11. Monitoring</td>
<td>No consideration to monitoring of recommended works.</td>
<td>Need to monitor mentioned.</td>
<td>Map shows monitoring points and strategy described.</td>
<td>Range of monitoring options given with preferred strategies recommended and mapped.</td>
<td></td>
</tr>
<tr>
<td>12. Biosecurity and emergency planning.</td>
<td>No consideration given/ no response to any biosecurity or emergency planning criteria.</td>
<td>Mention given or poor understanding of biosecurity and emergency planning issues.</td>
<td>Understanding of biosecurity and emergency planning issues.</td>
<td>Thorough understanding of biosecurity and emergency planning issues. Good evidence of ideas being used in plan.</td>
<td></td>
</tr>
</tbody>
</table>

**Total Marks:**

**Comments:**


16. APPENDIX 5: Cover page template

Cover page

2018 Property Planning Competition Entry

Glen Innes Agricultural Research and Advisory Station

Name of school:

Name of contributing student/s:

Year of Student/s:

Date submitted:
16. APPENDIX 5: Cover page template

Cover page

2018 Property Planning Competition Entry

Glen Innes Agricultural Research and Advisory Station

Name of school:

Name of contributing student/s:

Year of Student/s:

Date submitted: