Physical and biological resources of the farm:

SOILS

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DPI in SCHOOLS

NSW GOVERNMENT
Department of Primary Industries

Tocal COLLEGE
RTO 91166

Acknowledgements

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Physical and biological resources of the farm-Soils

An understanding of soils is integral to all stages in the NSW Agriculture syllabus. The following resource provides engaging authentic learning activities to develop and challenge student understanding of the concept based around the Tocal virtual farm resource. This resource addresses the NSW Agriculture Syllabus Stage 6 Farm Case study outcomes, with cross curricular connections.

Outcomes:

P1.1 describes the complex, dynamic and interactive nature of agricultural production systems

P1.2 describes the factors that influence agricultural systems.

P2.3 describes the farm as a basic unit of production

For the best learning outcomes we suggest students visit Tocal College, CB Alexander Campus to carry out the first hand observations and practical activities associated with the Farm Case Study syllabus requirements. Farm tours are accessible year round via appointment.

The following section requires students to utilise the Tocal College resources to complete the following worksheet and activities.

- ESRI Story Maps
- Soils of Tocal
- Tocal Property and Farms

Glossary:

Humus: decomposed organic matter that is dark brown/black in colour. It is a colloid and reactive, cementing soil particles together thus, improving a soils structure. It has a negative surface charge, high water holding capacity (WHC), high cation exchange capacity (CEC) and encourages microbial activity.

Parent material: the material that soil develops from. It may be rock that has decomposed in place, or eroded material that has been deposited by wind, water, or ice. The nature of the parent material strongly influences soil properties such as texture, pH, fertility, and mineralogy. For example, coarse-grained, quartz-rich parent material such as glacial outwash generates gravely soils with a coarse (sandy) texture.

pH: (potential of hydrogen) is a scale of acidity from 0 to 14. It indicates how acidic or alkaline a substance is. More acidic solutions have lower pH while more alkaline solutions have higher pH. Substances that are not acidic or alkaline have a pH of 7 and are termed neutral. Each one-unit change in the pH scale corresponds to a ten-fold (logarithmic) change in hydrogen ion concentration.

Soil: thin outer layer covering the earth (lithosphere). Made up of five components:

- Mineral particles (sand, silt and clay);
- Organic Matter- dead and decaying plants animals and animal products
- Water
- Gas- this fills the spaces (pores) between soil particles
- Organisms- living organisms such as macro and micro invertebrates, bacteria, fungi and protozoa.

Soil horizon: A soil horizon makes up a layer of soil. The horizon runs roughly parallel to the soil surface and has different properties and characteristics than the adjacent layers above and below. Characteristics used to distinguish between horizons are obvious physical features, such as soil particles, colour and texture. Horizons are obvious in some soils, because changes in soil appearance are abrupt, however, in many soils the change is more gradual and horizons are hard to distinguish. Horizons are categorised as the following:

- O horizon (surface organic litter) This is the layer of organic matter sitting on top of the soil. It tends to be deepest in undisturbed forest environments.
- A1 horizon (topsoil). This is the surface soil, referred to as topsoil. It has the most organic matter and biological activity of any of the horizons. The decayed organic matter (humus) darkens the soil colour.
- A2 horizon (topsoil). This layer is not present in all profiles. It frequently has a pale, bleached appearance and is poorly structured. Bleaching is an indication of periodic waterlogging often due to formation of a 'perched' watertable above a relatively impermeable subsoil.
- B horizon (subsoil). This horizon frequently has more clay than topsoil. In clay soils, the difference in clay content between the A and B horizons is less than those for other soils, such as the red brown earths, where the topsoil is loamy or sandy.
- C horizon (weathering rock). This layer may be very deep, and may not be present in the root zone of many vegetable-growing soils.

Soil profile: A soil profile is a vertical section of the soil that depicts all of its horizons. It allows you to examine the layers of the soil from the surface down to the rock or sediment from which the soil was formed (parent material).

Soil salinity: both soil salinity and sodicity are caused by accumulation of too much salt in the soil.

Salinity is the presence of soluble salts in the soil solution. Elements contributing to salinity include cations: Sodium (Na+), Magnesium (Mg2+), Potassium (K+), Calcium (Ca+), Ammonium (NH_{4+}), and anions Chloride (Cl-), Sulphate (SO4 2-), Carbonate (CO3 2-), Bicarbonate (HCO3 -) and Nitrate (NO3 2-).

Soluble salts occur naturally in Australian soils; however the accumulation of these salts can be amplified through inefficient irrigation practices or inefficient fertiliser usage. Excess soluble salts in the root zone reduce plant growth through osmotic stress or specific ion toxicities.

Soil sodicity: caused by the presence of sodium (Na+) (cation) attached to clay in soil. A soil is considered to be sodic when the sodium reaches a concentration where it begins to affect soil structure. The sodium weakens the bonds between soil particles. When the soil is wetted the clay particles become detached and spread out (disperse). The soil solution will appear cloudy and the soil structure will be poor. Water infiltration, gas exchange and drainage can be negatively affected by dispersed clay particles. Sodic soils are very prone to erosion.

Soil structure: Structure refers to the **arrangements** of soil particles. It describes the way which the sand, silt and clay peds are arranged or aggregated. Structure influences the amount and nature of porosity, affects tilling capability, nutrient retention, drainage, water holding capacity (WHC) and root penetration. Structure can be degraded or improved through farming practice.

Soil texture: Texture refers to the **proportion** of sand, silt and clay sized particles that make up the mineral fraction of the soil. Texture influences the soils minerology, ability for draining, WHC, nutrient retention and CEC, tilling workability and root penetration. Soil texture cannot easily be naturally altered.

Soils on Tocal (Australian Soil Classification)

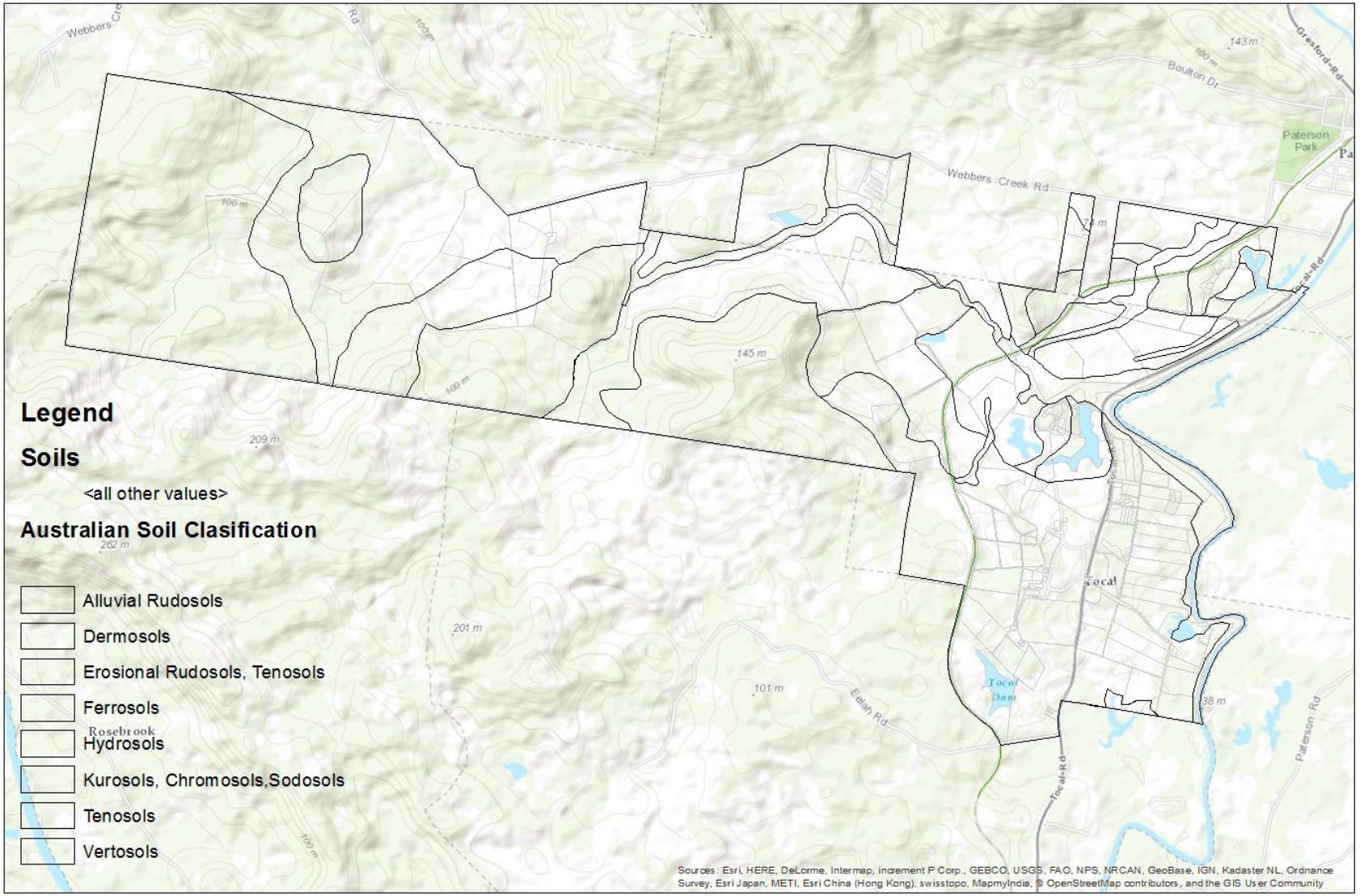

Figure 1 Soils on Tocal (Australian Soil Classification)

Chromosols, Kurosols and Sodosols

1. Make a key and identify the location of Chromosols, Kurosols and Sodosol soils on the Tocal College map at left (Figure 1). Label the location of "Springer 2" and "Creek paddock".

2. Define duplex soil:

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3. Define acidic soil:

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4. Identify common features of Tocal Chromosol, Kurosol and Sodosol soil types:

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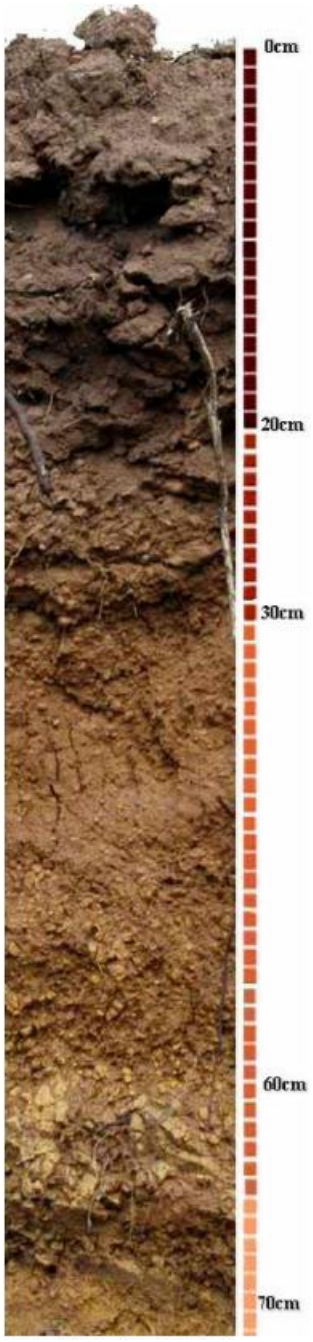
5. Label and describe a Kurosol-"Springer 2" and Chromosol- "Creek paddock" soil profile.

Soil Type	Soil Profile	Profile Description
Kurosol "Springer 2"		

Soil Type	Soil Profile	Profile Description
Chromosol "Creek paddock"		

Rudosols and Tenosols

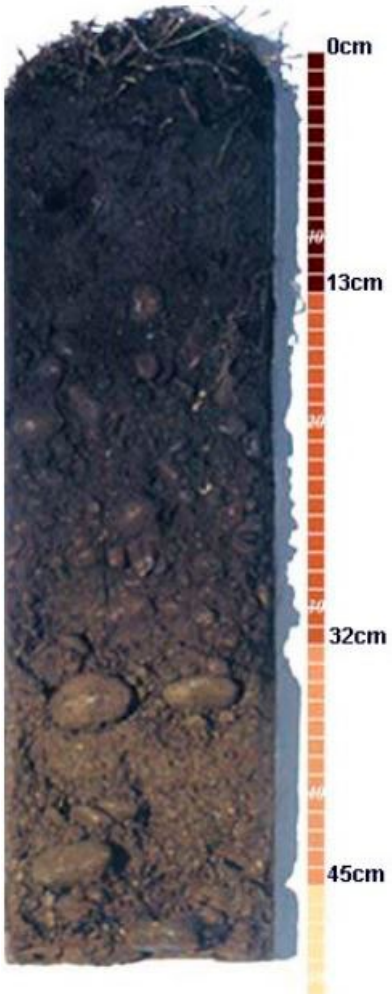
6. Make a key and identify the location of Rudosol and Tenosol soils on the Tocal College map (Figure 1). Label the location of "Windmill paddock" and "View Paddock".

7. Contrast the Tocal Alluvial Rudosols and Erosional Rudosols and Tenosols in the following table:

Alluvial Rudosols	Erosional Rudosols and Tenosols

8. Label and describe a Rudasol-"Windmill paddock" and Tenasol- "View Paddock" soil profile.

Soil Type	Soil Profile	Profile Description
Rudasol- "Windmill paddock"		

Soil Type	Soil Profile	Profile Description
Tenasol- "View Paddock"		

Hydrosols

9. Make a key and identify the location of Hydrosol soils on the Tocal College map (Figure 1). Label the location of "the Top flat"

10. Identify the features of Tocal Hydrosol soils.

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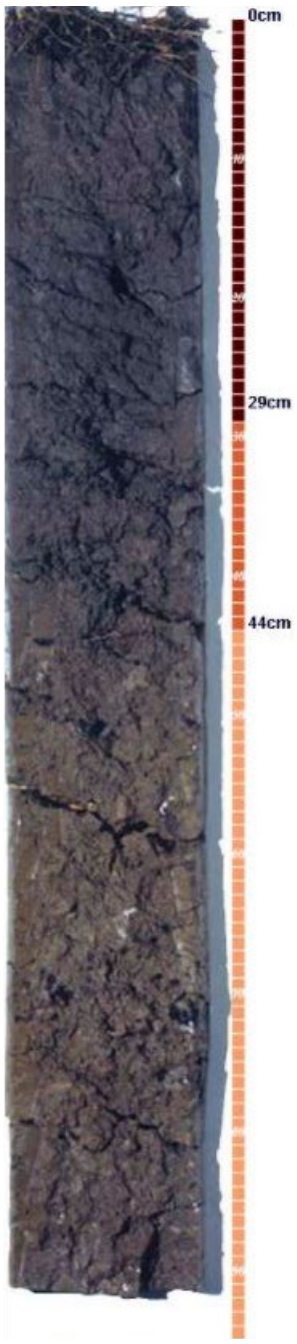
11. Label and describe a Hydrosol-"the Top flat" soil profile.

Soil Type	Soil Profile	Profile Description
Hydrosol- "the Top flat"		

Black Vertosols

12. Make a key and identify the location of Black Vertosol soils on the Tocal College map (Figure 1) Label the location of "Phillips paddock".

13. Identify the features of black Vertosol soils.

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14. Label and describe a Vertosol-"Phillips paddock" soil profile.

Soil Type	Soil Profile	Profile Description
Vertosol- "Phillips paddock"		

Dermosols

15. Make a key and identify the location of Dermosol soils on the Tocal College map (Figure 1) Label the location of "Calving paddock".

16. Identify the features of Tocal Dermosol soils.

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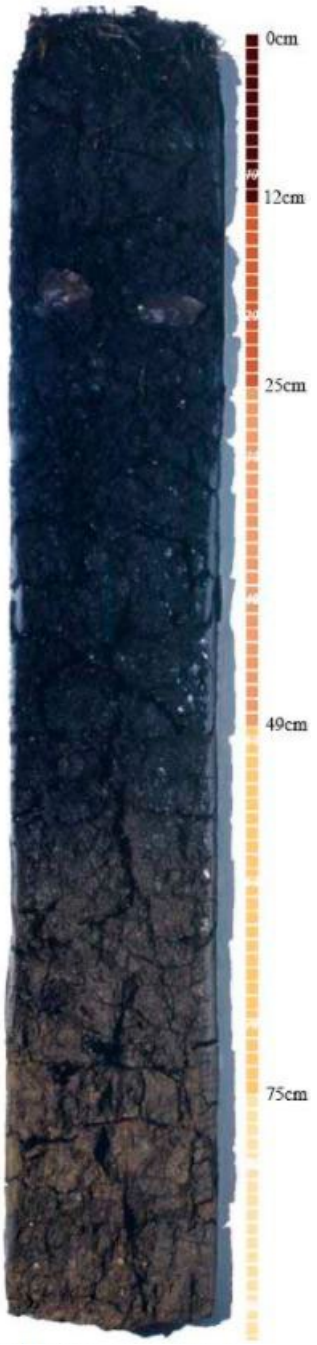
17. Label and describe a Dermosol-"Calving paddock" soil profile.

Soil Type	Soil Profile	Profile Description
Dermosol- "Calving paddock"		

Red ferrosols

18. Make a key and identify the location of Red Ferrosol soils on the Tocal College map (Figure 1) Label the location of "Bowkers paddock".

19. Identify the features of Tocal Red Ferrosol soils.

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20. Label and describe a Red Ferrosol -"Bowkers paddock" soil profile.

Soil Type	Soil Profile	Profile Description
Red Ferrosol- "Bowkers paddock"		

Summary Questions

1. Explain why soils that developed on steep slopes are more eroded than soils developed on gentler slopes.

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2. Soils developed in flat lying regions typically have _____ topsoil (A horizon) than those developed in sloping regions.

3. Layers that appear within a soil are referred to as _____ _____.

4. A vertical section exposing a soil represents its _____.

5. Identify which horizon is characterised by organic debris in various stages of decay?

_____

6. Identify which horizon is characterised by humus mixed with mineral and rock fragments?

_____

7. Identify which horizon is characterised by the accumulation of clay-sized particles?

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8. Identify which horizon is characterized by recognizable pieces of parent material?

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9. List essential elemental nutrients do plants and animals extract from the soil and atmosphere?

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10. List the macro elements that Australian soils are characteristically low in?

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11. Explain how can soil pH impact production?

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12. A) Contrast good and poor soil structure. Show how things are different or opposite.

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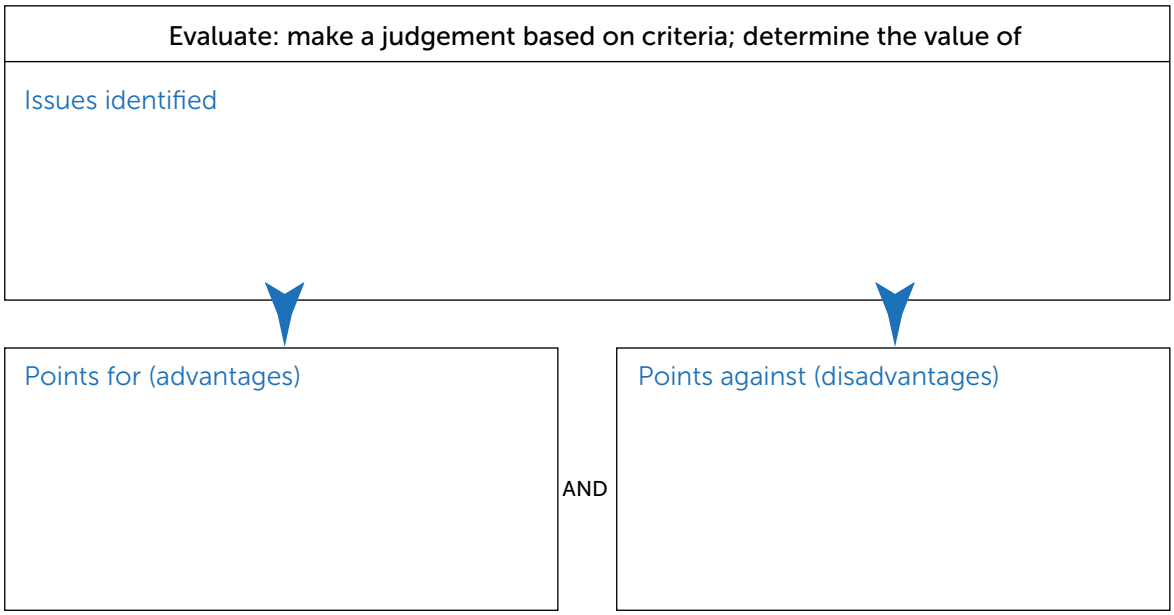
B) Discuss how soil structure can be managed to improve production? Use the scaffold if required to provide points "for" and "against".



(Source: Sewell 2002, *Scaffolds for key words*)

Practical Activities

Carry out the following soil practical investigations at the Tocal farm.

- Soil Profile analysis: Observe soil profiles from Tocal College:
  - » Springer 2
  - » Creek paddock
  - » Windmill paddock
  - » View paddock
  - » The top flat
  - » Phillips paddock
  - » Calving paddock
  - » Bowkers paddock

- Soil Texture: Conduct texture analysis from a range of paddocks investigated, using the ribboning method
- Soil pH: Conduct pH analysis from a range of paddocks investigated.
- Soil Sodicity: Conduct sodicity (slaking and dispersion) analysis from a range of paddocks investigated.

Follow this link for investigation procedure.

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Available on the iBookstore

Water on Tocal

Hathway, J 2017, '*Water on Tocal*' NSW Department of Primary Industries, Tocal College, https://www.arcgis.com/apps/MapSeries/index.html?appid=ec24797e7d9943f5a407b7d3c34b8859, viewed 19 February 2018

Target Outcomes

Outcomes	Content
P1.1 describes the complex, dynamic and interactive nature of agricultural production systems P1.2 describes the factors that influence agricultural systems. P2.3 describes the farm as a basic unit of production	• observe, collect and record information on the physical and biological resources of the farm, including soil, climate, vegetation, topography, water and infrastructure • measure and describe the features of soil including colour, texture, structure, pH, organic matter, parent material and water-holding capacity • identify macro and micro nutrients important for plant growth

Cross Curricular Outcomes

Agriculture Stage 6- HSC

Outcomes	Content
H2.1 describes the inputs, processes and interactions of plant production systems	• describe chemical characteristics of a soil including soil pH, ion exchange capacity, soil carbon and nutrient status • describe physical characteristics of a soil including soil structure, texture, porosity and bulk density • perform a first-hand investigation to analyse and report on the physical and chemical characteristics of a soil

Agriculture Stage 4-5

Outcomes	Content
4.3.3/ 5.3.3 Explains and evaluates the impact of management decisions on plant production enterprises	• examine soil texture, structure, pH and profiles
4.5.1/ 5.5.1 Designs, undertakes, analyses and evaluates experiments and investigates problems in agricultural contexts	• investigate an agricultural problem and develop possible solutions • conduct a controlled experiment to investigate an enterprise-related problem • gather data using a range of technologies