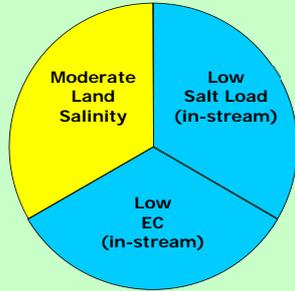


12. Kowen Hydrogeological Landscape

LOCALITIES	Kowen Forest, Kowen Settlement	
MAP SHEET	Canberra 1:100 000	
CONFIDENCE LEVEL	Moderate	

OVERVIEW

The Kowen Hydrogeological Landscape (HGL) extends from east of Queanbeyan to the northern and eastern catchment boundaries of the ACT (Figure 1). The HGL covers an area of 62 km² and receives 600 to 750 mm of rain per annum.

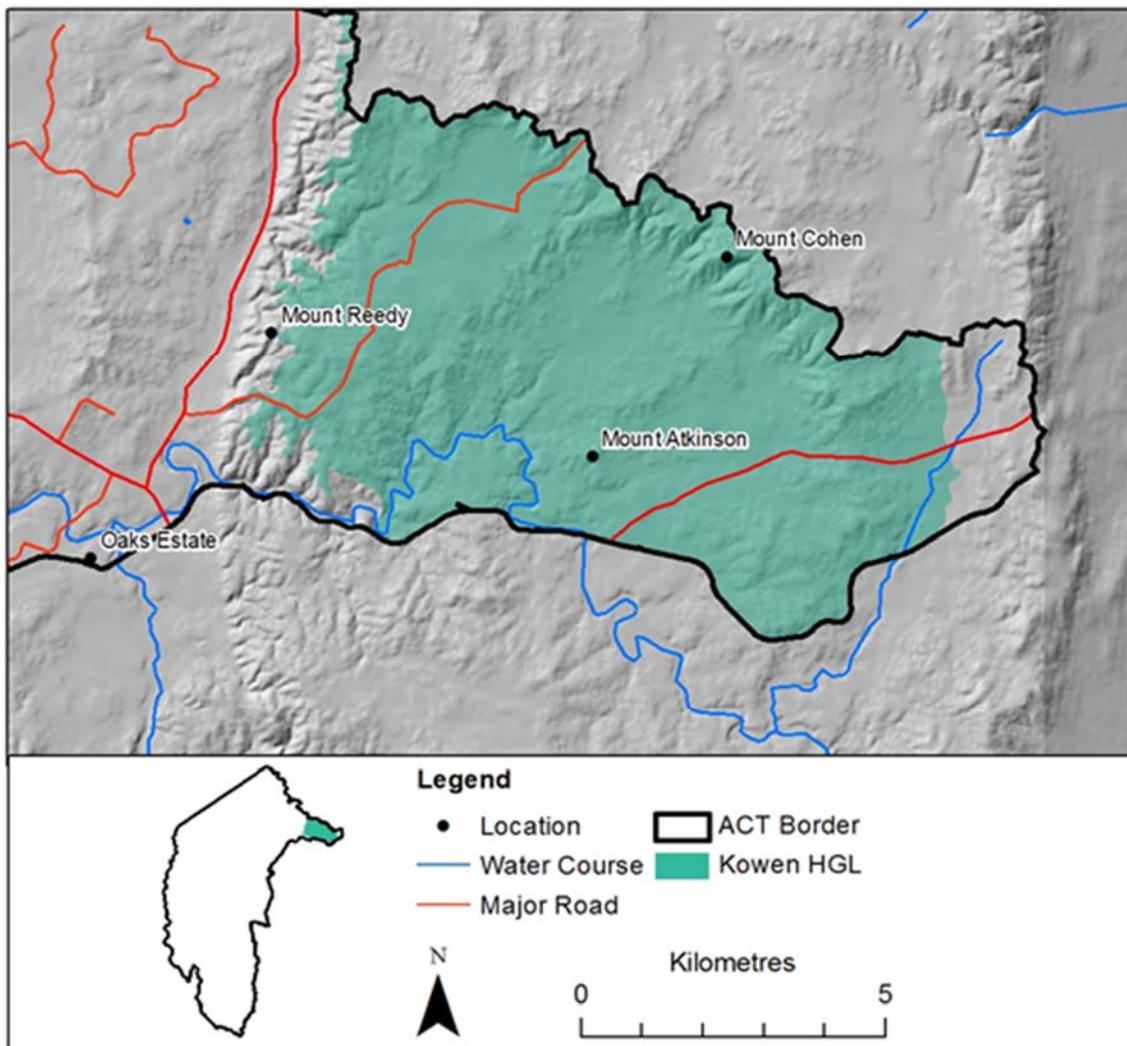


Figure 1: Kowen HGL distribution map.

Kowen HGL is defined by catchment, soil landscape and geological boundaries (Figure 2) and principally consists of Adaminaby Group Ordovician metasediments. The area is mostly covered in commercial forestry operations of the Kowen Pine Plantation with cleared areas in the lower landscape used for grazing.

There are some waterlogged and moderately saline discharge sites in the lower slope areas that are also subject to erosion.

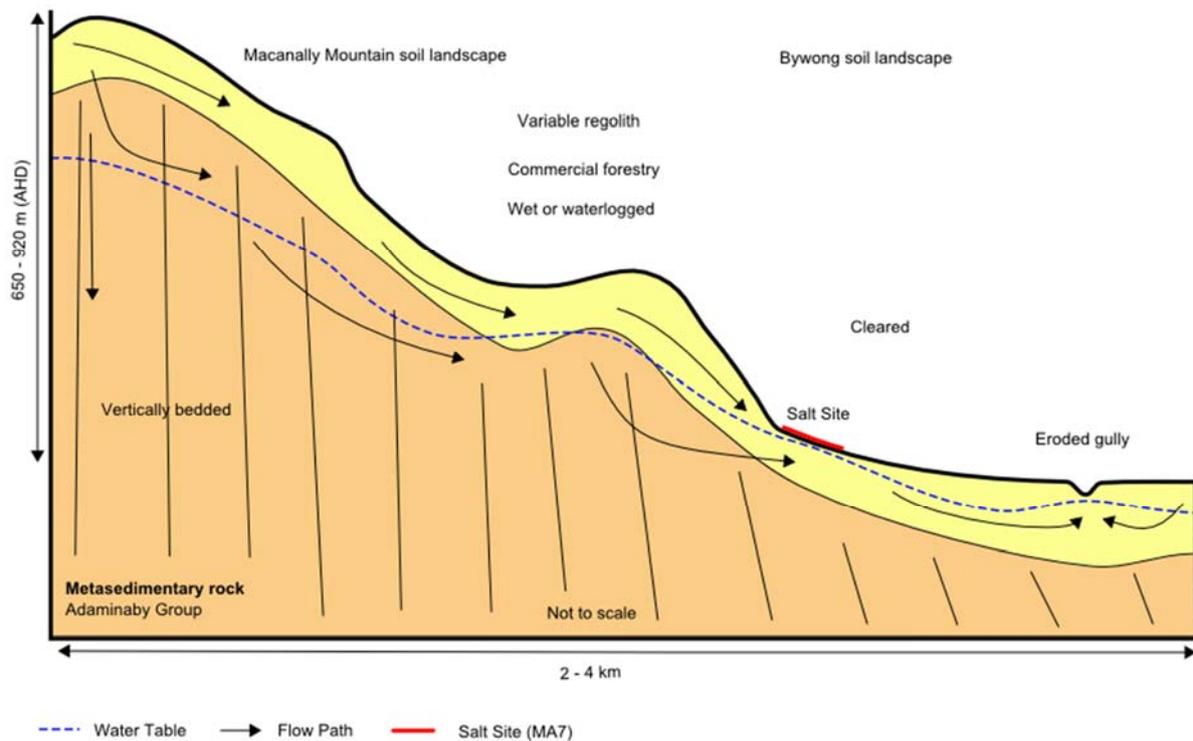


Figure 2: Conceptual cross-section for Kowen HGL showing the distribution of regolith and landforms, salt sites present, and flow paths of water infiltrating the system.

Land salinity has been observed in this HGL (Table 1).

Table 1: Kowen HGL salinity expression.

SALINITY EXPRESSION	
Land Salinity (Occurrence)	Moderate – observed salt land symptoms are evident in the lower landscape with areas of waterlogging. The sites have species change and are also eroded.
Salt Load (Export)	Low – no surface water quality data available. Creeks are highly intermittent.
EC (Water Quality)	Low – no surface water quality data available.

Salt store refers to the amount of salt stored in soil and geology materials. Salt availability refers to how easily this salt can be moved by water. Salt stored within Kowen HGL has moderate mobility. There is a moderate salt store that has moderate availability (Table 2).

Table 2: Kowen HGL salt store and availability.

SALT MOBILITY			
	Low availability	Moderate availability	High availability
High salt store			
Moderate salt store		Kowen	
Low salt store			

Overall salinity hazard is based on the likelihood of salinity occurring and how much impact it would have. The overall salinity hazard in Kowen HGL is low. This is due to the moderate likelihood that salinity issues will occur and that they would have potentially limited impacts (Table 3).

Table 3: Likelihood of salinity occurrence, potential impact and overall hazard of salinity for Kowen HGL.

OVERALL SALINITY HAZARD			
	Limited potential impact	Significant potential impact	Severe potential impact
High likelihood of occurrence			
Moderate likelihood of occurrence	Kowen		
Low likelihood of occurrence			

LANDSCAPE FEATURES

The following photographs illustrate landscapes and specific features observed in this HGL. Information used to define the HGL is summarised in Table 4.



Photo 1: Landscape view to the north from the Federal Highway with soil conservation earthworks in the foreground and pine forest in the background (Photo: DPI / A Nicholson).



Photo 2: Kowen Pine Forest in the background with waterlogged gully line evident at lower mid slope situation (Photo: DPI / A Nicholson).



Photo 3: Photograph to the north from the Federal Highway across Kowen HGL indicating native roadside vegetation (Photo: DPI / A Nicholson).



Photo 4: Cutting of Adaminaby Group metasediments adjacent to the Federal Highway on the western margin of Kowen HGL (Photo: DPI / A Nicholson).

Table 4: Summary of information used to define Kowen HGL.

Lithology <i>(Raymond et al. 2007; Geoscience Australia 2015)</i>	This HGL comprises Ordovician metasediments. The key lithology is: <ul style="list-style-type: none"> • Adaminaby Group
Annual Rainfall	600–750 mm
Regolith and Landforms	Soil generally < 1 m with deeper pockets associated with flow lines. Deeper soil and imperfect drainage in the lower landscape provide moderate potential for salt store Slope class 0–10% with higher slopes of 10–32% Elevation range is 650–900 m
Soil Landscapes <i>(Jenkins 1993; Jenkins 2000; Cook & Jenkins in prep)</i>	The following soil landscapes are dominant in this HGL: <ul style="list-style-type: none"> • Macanally Mountain • Bywong • Foxlow (minor) Rapidly drained Clastic Rudosols (Lithosols) on crests, upper slopes and near rock outcrop. Moderately well drained Red Chromosols (Red Podzolic Soils) and Brown Chromosols (Yellow Podzolic Soils and Non-calcic Brown Soils) on mid slopes. Imperfectly drained Bleached-sodic Chromosols (Yellow Podzolic Soils) and poorly drained Sodosols (Solodic Soils) in drainage lines and lower slopes.
Land and Soil Capability	Class 6
Land Use	<ul style="list-style-type: none"> • forestry (pines)
Key Land Degradation Issues	<ul style="list-style-type: none"> • gully erosion • waterlogging • salinity • soil acidity
Native Vegetation <i>(Keith 2004; Gellie 2005; Dept. of Environment 2012)</i>	This HGL is situated within the IBRA7 South Eastern Highlands (Murrumbateman subregion) The HGL has been extensively cleared with remaining vegetation formations of Dry Sclerophyll Forest Local vegetation is described by Gellie (2005)

HYDROGEOLOGY

Typical values for the hydrogeological parameters of this HGL are summarised in Table 5.

Table 5: Summary of values for typical hydrogeological parameters of Kowen HGL.

Aquifer Type	Unconfined to semi-confined in fractured rock and saprolite Lateral flow through unconsolidated colluvial and alluvial sediments on slopes and in flow lines
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Hydraulic Conductivity	Moderate Range: 10 ⁻² –10 m/day
Aquifer Transmissivity	Low Range: <2 m ² /day
Specific Yield	Low Range: <5%
Hydraulic Gradient	Gentle to moderate Range: <10–30%
Groundwater Salinity	Fresh Range: <800 µS/cm
Depth to Watertable	Shallow to intermediate Range: <2–8 m
Typical Sub-Catchment Size	Small (<100 ha)
Scale (Flow Length)	Local Flow length: <5 km (short)
Recharge Estimate	Moderate
Residence Time	Medium (years)
Responsiveness to Change	Medium (years)

MANAGEMENT OPTIONS

Overarching salinity management strategies have specific biophysical outcomes. These are achieved by implementing a series of targeted land management actions that take into account the opportunities and constraints of the particular HGL. The actions recognise the need for diffuse and specific activities within the landscape to impact on salinity. Further explanation of land management functions, strategies and actions can be found in Wooldridge *et al.* (2015).

Salinity is driven by interactions between water-use capacity of vegetation, physical soil properties and hydrogeological processes within the HGL.

Actions that influence the way water is used by vegetation or stored in the soil profile will have impacts on recharge. The influence of both continual and episodic recharge and the impacts of extreme weather events should be considered when deciding on appropriate management actions. Short and long-term climate cycles also should be considered as they have a bearing on salinity processes, particularly salt load and land salinity.

Landscape Functions – Kowen HGL

Functions this landscape provides within a catchment scale salinity context:

- **B.** The landscape provides fresh water runoff as an **important dilution flow source**.

- **H.** The landscape contains high hazard for generating sodic and saline sediments.

Landscape Management Strategies – Kowen HGL

Appropriate strategies pertinent to this landscape:

- **Discharge rehabilitation and management (4):** Discharge sites appear in the landscape through wet climate cycles. Improved management of these saline areas can reduce the impact of salinisation and prevent large negative impacts during wet cycles. Discharge management will also limit on-site land degradation.
- **Dry out the landscape with diffuse actions over most of the landscape (6):** Encourage plant growth and increase plant water use in order to use excess soil moisture and shallow groundwater. Healthy, actively growing vegetation will also buffer groundwater accessions in wet seasonal conditions.

Key Management Focus – Kowen HGL

This landscape has the potential for salinity but this potential is minimised by the widespread forestry. Logging will need to address sound erosion control measures and construction of access tracks will need to minimise sediment delivery. The landscape is well suited to forestry and this is very appropriate for salinity control.

Specific Land Management Opportunities

Specific opportunities for this HGL:

- forestry industry is present in the landscape with widespread plantations.

Specific Land Management Constraints

Constraints on land management in this HGL include:

- access, particularly for logging activities
- soil fertility
- soil erodibility
- fire regime will have a large impact on the hydrology of this HGL.

Specific Targeted Actions

Management areas for this HGL are illustrated in Figures 3 and 4. The specific management actions for these areas are described in Table 6.

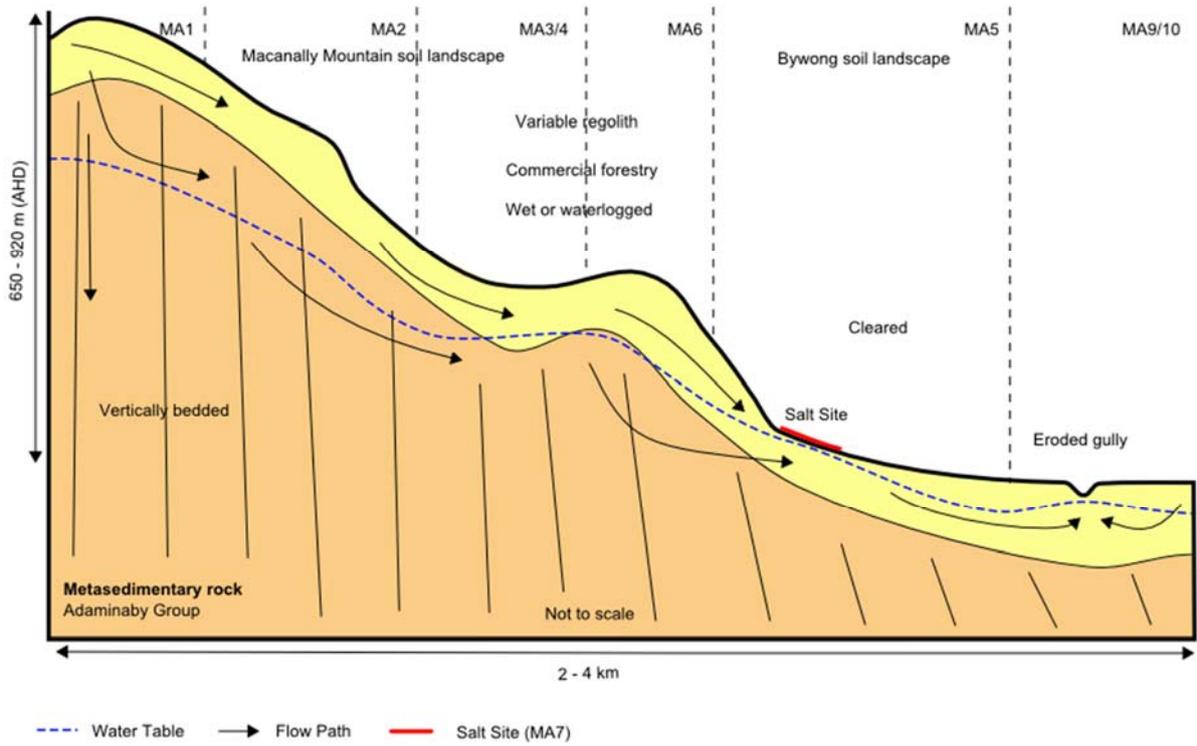


Figure 3: Management cross-section for Kowen HGL showing defined management areas.

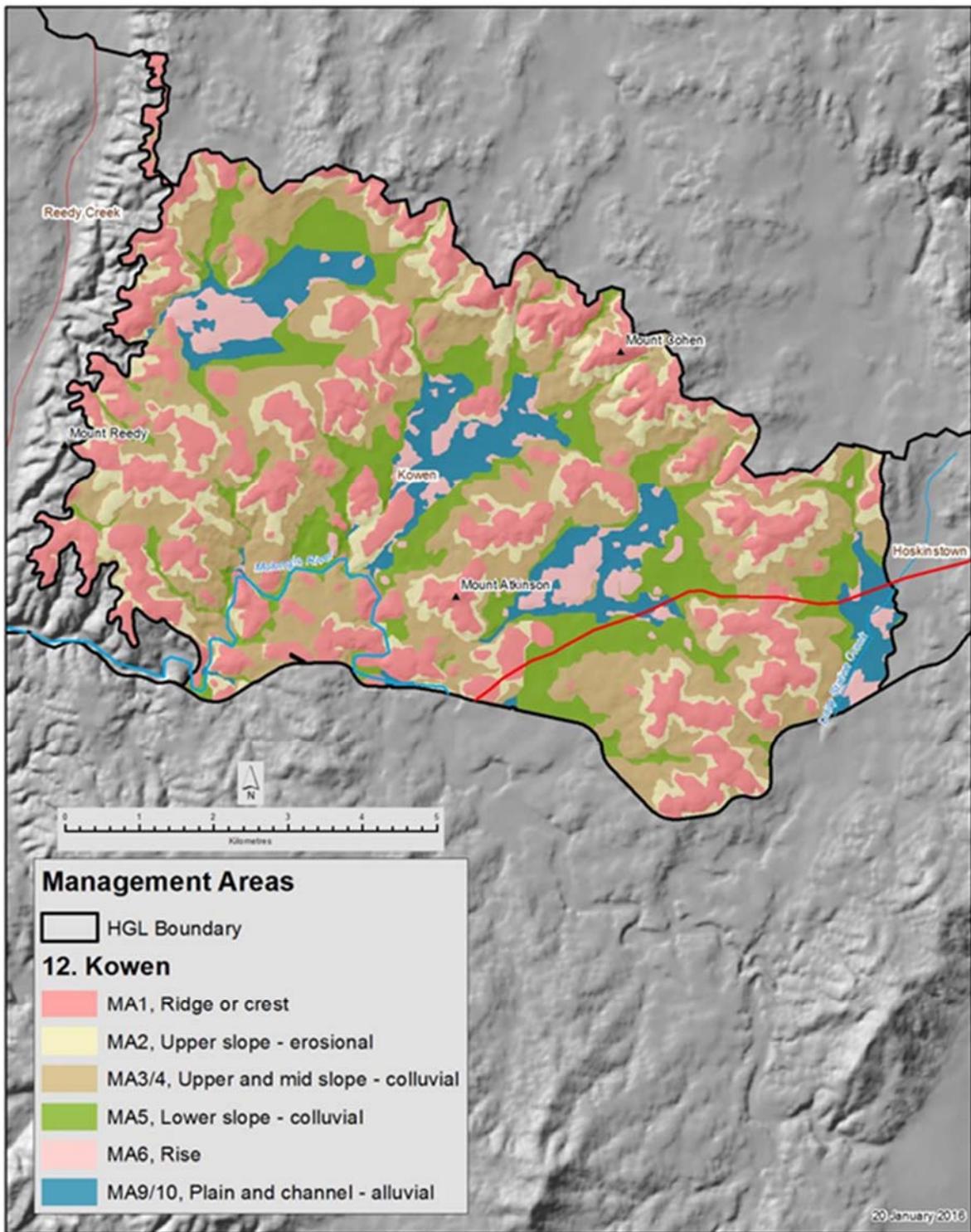


Figure 4: Spatial distribution of management areas for Kowen HGL.

Table 6: Specific management actions for management areas within Kowen HGL.

Management Area (MA)	Action
MA 1 (RIDGES)	<p>Vegetation for ecosystem function Maintain and improve existing native woody vegetation to reduce discharge (VE3)</p> <p>Vegetation for production Establish commercial forestry to manage recharge (VP7)</p>
MA 2 (UPPER SLOPES – EROSIONAL)	<p>Vegetation for production Establish commercial forestry to manage recharge (VP7)</p>
MA 3/4 (UPPER SLOPES – COLLUVIAL & MID SLOPES)	<p>Vegetation for production Establish commercial forestry to manage recharge (VP7) Revegetation of non-agricultural land with native species to manage recharge (VP8)</p>
MA 6 (RISES)	<p>Vegetation for production Establish commercial forestry to manage recharge (VP7) Revegetation of non-agricultural land with native species to manage recharge (VP8)</p>
MA 5 (LOWER SLOPES – COLLUVIAL) NB: INCLUDES MA7 – SALT LAND	<p>Vegetation for production Establish commercial forestry to manage recharge (VP7) Revegetation of non-agricultural land with native species to manage recharge (VP8)</p> <p>Salt Land Rehabilitation Rehabilitation of salt land to minimise onsite and offsite degradation (SR4) Establish and manage salt land pasture for productive use of salt land (SR2)</p>
MA 9/10 (FLOWLINES)	<p>Vegetation for ecosystem function Maintain and improve riparian native vegetation to reduce discharge to streams (VE4)</p>

High Hazard Land Use

There are some management actions that should be discouraged in this HGL as they will have negative impacts on salinity (Table 7).

Table 7: Management actions having negative salinity impacts in Kowen HGL.

At Risk Management Areas	Action
MA 1, 2 & 3/4	<p>Clearing and poor management of native vegetation (DLU4) Deep ripping of soils to maximise water infiltration to subsoil (DLU11)</p>

At Risk Management Areas	Action
MA 5/6	Poor management of grazing pastures (DLU2) Clearing and poor management of native vegetation (DLU4) Locating infrastructure on discharge areas (DLU7) Deep ripping of soils to maximise water infiltration to subsoil (DLU11)
MA 9/10	Clearing and poor management of native vegetation (DLU4)

REFERENCES

- Department of the Environment 2012, *Interim Biogeographic Regionalisation for Australia (IBRA), Version 7 (Regions)*, Australian Government, Department of the Environment, Canberra, ACT
- Gellie, N.J.H. 2005, Native vegetation of the Southern Forests: South-east Highlands, Australian Alps, South-west Slopes and SE Corner bioregions, *Cunninghamia* 9(2), pp 219–253
- Geoscience Australia, 2015, *Australian stratigraphic units database*, Canberra, ACT, [Accessed: 20 June 2015] http://dbforms.ga.gov.au/www/geodx.strat_units.int
- Jenkins B.R. 1993, *Soil Landscapes of the Michelago 1:100 000 Sheet map and report*, Department of Conservation and Land Management, Sydney, NSW
- Jenkins B.R. 2000, *Soil Landscapes of the Canberra 1:100 000 Sheet map and report*, Department of Land and Water Conservation, Sydney, NSW
- Keith, D. A. 2004, *Ocean shores to desert dunes: the native vegetation of New South Wales and the ACT*, NSW Department of Environment and Conservation, Hurstville, NSW
- Raymond, O.L., Lui, S., Kilgour, P., Retter, A.J., Stewart, A.J. and Stewart, G. 2007, *Surface geology of Australia 1:1,000,000 scale, New South Wales – 2nd edition*, Geoscience Australia, Canberra, ACT
- Wooldridge, A., Nicholson, A., Muller R., Jenkins, B. R., Wilford, J. and Winkler, M. 2015, *Guidelines for managing salinity in rural areas*, NSW OEH, Sydney, NSW (Accessed: 20 June 2015) <http://www.environment.nsw.gov.au/resources/salinity/150241-HGL-salinity-rural.pdf>