Wimmera Catchment Management Authority

Waterways for Life.

Glendhu Creek Waterway Action Plan

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Glendhu Creek

Waterway Action Plan

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Glossary

Term	Definition
aggradation	Deposition of material eroded or excavated elsewhere, raising the level of the stream bed.
armouring	A stable layer of the largest available sediment from which fines have been removed by stream flow. Acts to protect the streambed or bars from erosion.
bedrock	Exposed rock within the streambed. May act to prevent incision of the channel.
bench	Bank-attached, planar (flat) and narrow, deposits or erosional surfaces of fine grained sediment occurring at elevations between the stream bed and the floodplain
degradation	Erosive removal of materials from the stream bed, other geomorphic units or the floodplain, lowering their elevation.
confluence	The junction of two streams.
dynamic equilibrium	The condition of a stream that is experiencing relatively equal rates of degradation and aggradation. Dynamic equilibrium recognises that significant changes may occur rapidly in response to events such as flooding and fire resulting in dynamic short term change. However, over the long term the stream is in a state of dynamic equilibrium.
easting and northing coordinate system	A means of locating a position based on the Australian Map Grid (AMG) system. Used in conjunction with Global Positioning System (GPS) devices.
erosion	The group of natural processes, including weathering, dissolution, abrasion, corrosion, and transportation, by which material is worn away from the earth's surface.
alluvial fan	A low spreading (often triangular in planform shape) deposit of sediment where there is a considerable reduction in gradient along the stream.
fluvial-geomorphology	The study of the evolution and configuration of landforms as produced by the action of a river or stream.
geomorphology	The study of the evolution and configuration of landforms (see also fluvial-geomorphology).
headcut	Vertical, or near vertical drop in channel elevation greater than 300mm

Term	Definition
hydraulics	The physical science and technology of the static and dynamic behaviour of fluids.
hydrology	The scientific study of the properties, distribution and effects of water on the Earth's surface, in the soil and underlying rocks and in the atmosphere.
incision	Lowering or downward cutting of the channel level through water erosion
left bank	The streambank on a persons left hand side when facing downstream
nick point	Vertical, or near vertical drop in channel elevation less than 300mm (see also head cut)
planform	The form of a stream as viewed directly from above (such as can be seen in aerial photographs).
reach	The basic stream management unit. Often a length of stream with similar characteristics.
right bank	The streambank on a persons right hand side when facing downstream
riparian	From the Latin word for riverbank. Pertaining to riverbanks. Riparian vegetation refers to the vegetation along streambanks.
riverine	Relating to or resembling a river.
sinuosity	Ratio of the length of the channel between two points to the straight line distance between those two points
streampower	The ability of a stream to do work. Calculated as shear stress times flow velocity.
sodic soils	Soils with high concentration of sodium ions such that the structure of the soil is affected. Sodic soils are highly dispersible on contact with fresh water.
valley fill	A layer of sediment laterally confined within a valley.

Abbreviations

ASL	Above Sea Level
DSE	Department of Sustainability & Environment
EVC	Ecological Vegetation Class
ISC	Index of Stream Condition
LWD	Large Woody Debris
NRM	Natural Resource Management
RHA	Rapid Habitat Assessment
WAP	Waterway Action Plan
Wimmera CMA	Wimmera Catchment Management Authority

Executive Summary

In 2001 the Wimmera Catchment Management Authority (Wimmera CMA) undertook a geomorphic investigation and analysis of the sediment processes within the Wimmera catchment (ID&A 2001). Entitled the 'Wimmera River Geomorphic Investigation' (ID&A 2001), this report identified an area of significant ecological and geomorphic value, in near pristine condition, located between the towns of Glynwylln and Glenorchy. This reach has since become known as the 'High Value Reach', and in accordance with the Victorian River Health Strategy (2002), the Wimmera CMA aims to protect this reach from any decline in condition.

The Wimmera River Geomorphic Investigation also identified a number of tributary streams that impact upon the health of the Wimmera River (ID&A 2001). As a major tributary, Glendhu Creek with a catchment area of 34km^2 and located approximately 33km east of the township of Stawell, was found to be a significant contributor of sediment to the Wimmera River. Unnaturally high sediment loads in a waterway can fill waterholes, smother habitat in the form of large woody debris and instream vegetation, and decrease channel capacity resulting in increased flooding. Mobilisation and downstream migration of sediment originating from erosion in the Glendhu Creek catchment therefore poses a significant threat to the values of Glendhu Creek, the Wimmera River and in particular the High Value Reach.

Although previous investigations have focused on protecting the Wimmera River, prior to the onset of erosion and incision events Glendhu Creek exhibited many of the features for which the Wimmera River is valued. Evidence from the soil profile in the downstream reaches of Glendhu Creek shows that a chain of ponds formation existed for a number of kilometres upstream of the Wimmera River confluence. Further upstream, flat gradients formed a discontinuous stream type as runoff descended from the steep hill country of the Pyrenees Range and spread over the floodplain.

Although the current form of Glendhu Creek no longer resembles its original condition, Wimmera CMA recognises that the creek has a value to the entire catchment of the Wimmera Region, and in order to address the issues of sediment generation and transport, has developed this Waterway Action Plan (WAP) for Glendhu Creek. The objectives of the plan are to;

1. Improve the health of Glendhu Creek and protect the High Value Reach (Reach 7) of the Wimmera River. This is to be achieved by determining appropriate actions to manage the current sediment load within Glendhu Creek.
2. Confirm values and threats identified from existing reports and community consultation, and develop appropriate management actions to enhance stream health within the catchment.
3. Develop appropriate management actions on a reach by reach basis, in conjunction with the catchment community.

The Waterway Action Plan also recognises that soil conservation works, rabbit control, deep ripping and pasture improvement programs have all been undertaken with success within the Glendhu Creek catchment. These works reflect the willingness of landholders to address the significant threat of erosion and its effect on large tracts of agricultural land.

Field investigations and discussions with landholders have led to the identification of the geomorphic processes that are occurring within the Glendhu Creek catchment. The following is a summary of these findings:

- Highly dispersive sodic soils that occur throughout the catchment are resulting in the generation of large volumes of sediment from active gully erosion in the upper catchment;
- Bank collapse and stream widening as a part of the natural recovery process in the middle and lower catchment are contributing significant volumes of sediment to downstream reaches.
- Flatter gradients in the lower reaches of Glendhu Creek form a sediment accumulation zone. In this area the natural process of stream recovery through sediment deposition can occur. This in turn will result in a decrease in the streambed gradient into the upper reaches if sediment is allowed to accumulate in the streambed. The process of bed deepening and bank collapse will then be slowed. Colonisation by vegetation of the streambank and sediment benches within the incised channel will provide further stability and ultimately reduce sediment transport to manageable levels.

As a result of these findings the focus of the management actions proposed in the Waterway Action Plan are to:

- Reduce and prevent ongoing sediment generation from all areas of the catchment, and;
- To trap and hold mobile sediment within the lower reaches of the creek.

While the focus of the Waterway Action Plan is upon actions aimed at improving stream health, the plan also recognises that there are many techniques available to achieve the same outcomes. Similarly, farm management practices including the establishment of perennial pastures and grazing management are significant contributors to reducing erosion causing run off during rainfall events. The plan also recognises that there are factors beyond the control of landholders, such as the significant grazing pressure of kangaroos which acts to reduce the effectiveness of revegetation and soil stabilisation programs.

Priorities for management actions were determined by undertaking a risk assessment process. In order to achieve this, Glendhu Creek and its tributaries were divided into seven management reaches based on the geomorphic processes that are occurring in each reach. Management actions were then developed on a reach by reach basis, and are based on providing the most cost effective solution to identified issues.

1 Introduction

In 2001, the Wimmera Catchment Management Authority (Wimmera CMA) undertook a geomorphic investigation and analysis of the sediment processes within the Wimmera catchment (ID&A 2001). The investigation focused on the Wimmera River and specific tributaries that are thought to have an impact on the health of the river. Located in the upper catchment (Figure 1), Glendhu Creek is a major tributary that was found to be a significant contributor of sediment to the Wimmera River. Mobilisation and downstream migration of this sediment, poses a threat to the high ecological and geomorphic values of the Wimmera River from Joel Joel to Glenorchy.

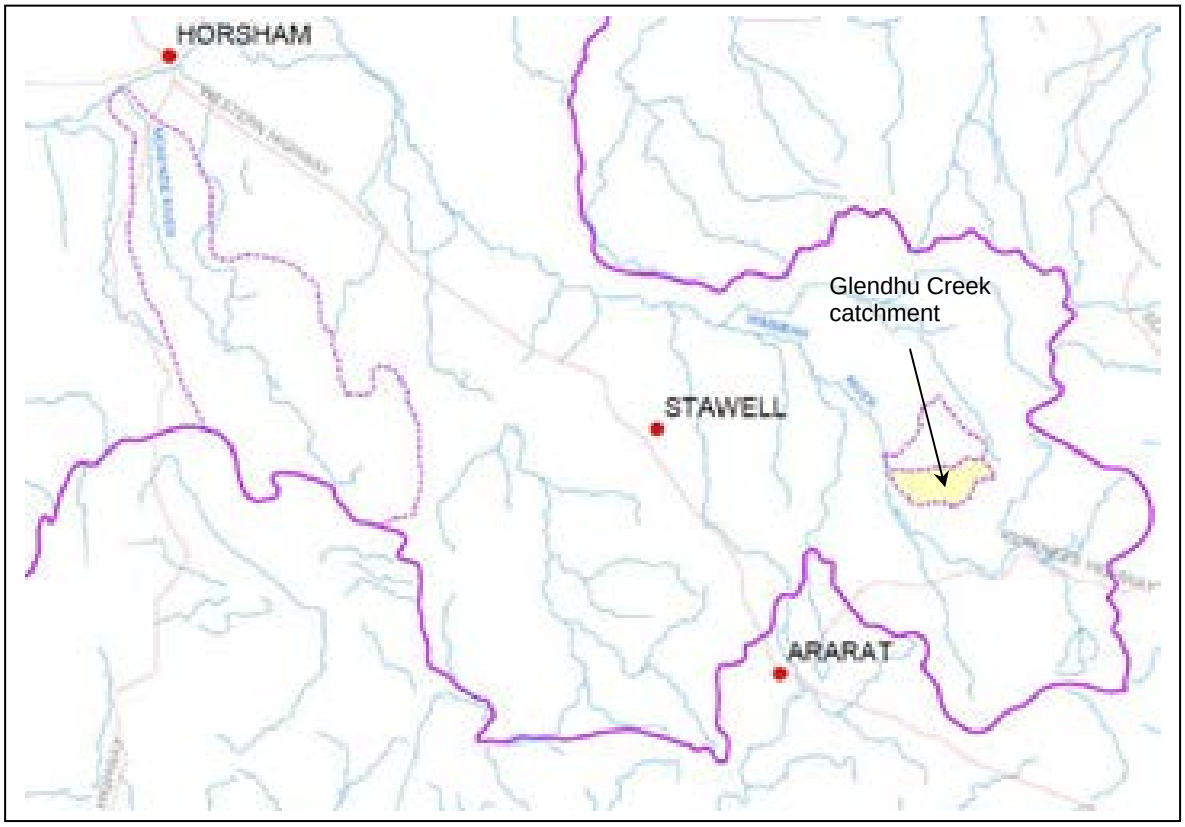


Figure 1. The location of the Glendhu Creek catchment within the Wimmera Catchment Management Authority boundary.

In order to reduce the risk posed by sediment to the high value reach, the Wimmera CMA proposes to undertake a stream management works program along Glendhu Creek. This report by Earth Tech Engineering Pty Ltd (Earth Tech) documents the analyses and outcomes of an investigation commissioned by the Wimmera CMA to develop a Waterway Action Plan (WAP) for Glendhu Creek. The plan, has been developed to guide management, and facilitate the implementation of waterway management works where required. The action plan includes:

1. The development of objectives for Glendhu Creek in accordance with state and regional priorities for management.
2. The current geomorphologic and ecological conditions of Glendhu Creek;
3. Values and threats to the creek, as perceived by stakeholders and the Glendhu Creek catchment community;
4. An assessment of risks to waterway health within the Glendhu Creek catchment, and;
5. A determination of waterway health targets for Glendhu Creek and a detailed action plan towards achieving these targets.

1.1 Scope

The scope for this project is set out in the Wimmera CMA Project Brief and comprises the following project tasks:

- A review of the relevant state and regional strategies;
- Development of detailed subcatchment management plan (Waterway Action Plans or WAP) detailing the risks and opportunities within each subcatchment, along with a set of prioritised management actions;
- Detailed subcatchment maps showing the location of proposed management actions;
- Identification of bed and bank instabilities;
- Location of pest plant and animal species that may pose a threat to waterway health at a sub reach scale;
- Extent and condition of riparian vegetation and fencing at a sub reach scale;
- Identification of high value assets and the risks and opportunities associated with these assets;
- An indicative budget to undertake management actions;
- Development of a WAP with a “Landscape” or whole of catchment approach to natural resource management (NRM);
- The WAP has been developed with consideration for other natural resource management (NRM) programs and projects planned or underway within the catchment.

The background review and field assessments identified many issues that have an impact upon waterway health. Management of a number of these issues is achieved within other works programs, strategies and plans developed by various management organisations and individual landowners. These issues and associated management programs are detailed in the Table 1.

Table 1. Waterway and land management programs relevant to the Glendhu Creek catchment.

Issues identified in Waterway Action Plan	Responding Strategy / Plan / Activity
Bank erosion	***Glendhu Creek Waterway Action Plan***
Stream bed instability	
In stream Water Quality	
In stream habitat	
Riparian zone revegetation	
Exotic pest plants	***Wimmera Weed Action Plan***
Whole farm and pasture management	***Steep Hill Country Management Plan***
	Whole Farm planning
Rabbits	***Wimmera Rabbit Management Action Plan***
Other exotic pest animals	***Victorian pest management framework***
Native pest animals	***Dept. Sustainability & Environment***
Native Vegetation Management	***Victorian Biodiversity Strategy***
	Shire Planning schemes

The Wimmera Catchment Management Authority plans to undertake a stream management works program along the Glendhu Creek, which has been identified as a high priority for management. The Waterway Action Plan, being prepared by Earth Tech Engineering, is to help guide the most appropriate management and facilitate the implementation of waterway management works where required. The development of local community support, the investigation of reach wide issues and the subsequent provision of a technical and financial basis for the works are important aspects of Waterway Action Plans.

This report includes

1. A review of regional and local objectives of the Wimmera CMA via objectives referenced in relevant regional strategies and investigations. These objectives are to be observed throughout the development of the Waterway Action Plan
2. A summary of catchment conditions, sourced from reports and investigations into waterway health within the Wimmera CMA region, and
3. A summary of values and issues raised at meetings with stakeholders and the Glendhu Creek catchment community.

2 Methodology

The Waterway Action Plan for Glendhu Creek was compiled using the following methodology:

2.1 Background Document Review

A desktop review of existing reports, investigations into waterway health issues and associated available data was undertaken. The aim was to provide:

1. A comprehensive list of waterway health issues. This list provided the basis for data collection during fieldwork and subsequent remedial action development;
2. A comprehensive list of stakeholders to be consulted during the development of the plan and the preparation of a stakeholder consultation plan. This plan was used to obtain stakeholder input on issues and concerns about the condition of Glendhu Creek and works planned for the catchment.

2.2 Engagement of Stakeholders and the Community

Public notices were placed in local newspapers and a letter drop was made to all roadside mailboxes within the catchment. This was undertaken at project inception to inform the community of the commencement of the project, identify opportunities for community involvement and advise people of the dates and venues for information sessions.

2.3 Field Assessments

A specialist team including a geomorphologist, waterway engineer and vegetation specialist undertook field assessments. The inspections were conducted in the presence of Wimmera CMA waterways staff and the landholder where possible. This approach permitted a continuous exchange of information by which all parties could learn from each other.

Information collected during the field inspections included:

- Past and present geomorphic condition;
- Contemporary vegetation condition and extent;
- Habitat quality, and;
- Fencing, revegetation and engineering works required.

The methodology applied to assess this information is elaborated upon in the following paragraphs.

2.3.1. Stream Health

Stream health in Victoria is assessed using the Department of Sustainability and Environment's (DSE) Index of Stream Condition (ISC). ISC assessments have not previously been undertaken on Glendhu Creek and were not a requirement of this project. However, field observations of the components that make up an ISC score (hydrology, physical form, streamside zone, water quality and aquatic life) indicate

that Glendhu Creek would rate poorly if an ISC assessment was to be made. In order to measure changes in stream health it is recommended that ISC assessments be carried out prior to the commencement of works.

2.3.2. Contemporary Vegetation Condition and Extent

The field condition and extent of contemporary vegetation, including native, exotic and weed species, was assessed by a vegetation specialist. Vegetation was then described in terms of the pre 1750's Ecological Vegetation Class (EVC) for the relevant bio-region. These classes are further defined in terms of their Bio-regional Conservation Status and may be described as listed in Table 2. Extensive plant species lists are provided in Appendix B to assist with the ISC process.

Table 2. Summary of EVC Bioregional Conservation Status Definitions.

Symbol	Conservation Status	Brief Definition
X	Presumed Extinct	Probably no longer present in the bioregion (or, if present, below the resolution of available mapping)
E	Endangered	<10% of pre-European extent remains (or a combination of depletion, loss of quality, current threats and rarity that gives a comparable status)
V	Vulnerable	10 - 30 % of pre-European extent remains (or a combination of depletion, loss of quality, current threats and rarity that gives a comparable status)
D	Depleted	>30% and up to 50% of pre-European extent remains (or a combination of depletion, loss of quality, current threats and rarity that gives a comparable status)
R	Rare	Rare as defined by geographic occurrence (total range generally <10 000ha, or pre-European extent in Victorian Bioregion <1000ha or patch size generally <100ha) but neither depleted, degraded nor currently threatened to an extent that would qualify as endangered, vulnerable or depleted
LC	Least Concern	>50% or pre-European extent exists and subject to little to no degradation over a majority of this area.

Source: Ecological Vegetation Class - Bioregional Conservation Status, Depletion & Tenure Area Statement on CD provided to consultants at the Native Vegetation Framework Training, September 2003.

2.3.3. Habitat Quality

Although not specifically required in the scope of this report, an assessment of habitat quality has been provided to enhance the value of the vegetation information collected. Note that sub-reach delineation was not determined prior to the commencement of the field inspection stage as this refinement was to be based on the geomorphic information derived from the field inspections. As a result, it was not possible to collect habitat quality information for all of the sub-reaches.

Habitat quality in the Glendhu Creek riparian zone was determined using the Rapid Habitat Assessment (RHA) method developed by DSE. This method is a modified version of the Habitat Hectares Method used in more comprehensive surveys. The RHA gives an estimate of vegetation / habitat quality using the following criteria,

- Retention of large old trees
- Retention of canopy cover

- Retention of the cover of, and diversity within, understorey life forms
- Presence of appropriate recruitment
- Absence of weeds
- Litter
- Logs (in woodlands and forests)
- Landscape context i.e. size of remnant patch and links to and size of neighbouring patches

At a particular site, native vegetation is assessed by comparing it to a benchmark which represents the average characteristics of a mature, long undisturbed stand of the same type of vegetation. The RHA therefore provides a 'snap-shot' of current habitat quality. Once current condition is established, sites may be ranked according to condition, enabling goals, minimum standards and management priorities to be formulated.

Habitat quality assessments vary throughout the Glendhu Creek catchment and as such the results are provided on a reach by reach basis in the Sub-Reach section of this report. Field notes for the assessment undertaken in each reach are provided in Appendix C.

2.4 Risk Assessment & Priority Setting for Management Actions

The risk assessment process assembled the information gathered during the document review, stakeholder consultation and field assessments. Each assessment considered the values and threats to the values at the inspection sites.

The first component of the analysis identified standardised environmental values in each reach and threats to these values (Appendix D). All values were assigned a rating from Very Good (5) through to Very Poor (1).

Environmental values were determined via information gathered in the literature review and from field observations. Social and economic values were assigned a subjective rating from Very Good (5) through to Very Poor (1) based on background document review and stakeholder and community consultation.

Threats have been given a similar rating from Very High (5) through to Very Low (1). Social threats and economic threats have been determined from consultation with stakeholders. Environmental threats have been determined from information gathered in the literature review and from field observations.

In order to determine the level of "Risk", the impact of a "Threat" on a "Value" is determined by multiplying the "Value x Threat", then multiplying this rating by standardised Likelihood and Trajectory.

"Likelihood and "Trajectory" are defined as follows:

Likelihood – i.e. what is the likelihood of this threat impacting on this value;

5-almost certain

4-quite possible

3-unusual but possible

2-remotely possible

1-practically impossible

Trajectory – i.e. what is the timescale created by this impact;

5-rapid

3-slow

1-stable

Trajectory provides a time scale when prioritising risk. Trajectory also varies between reaches and has therefore been identified for every risk in every reach.

The risk to a value was determined by the resultant score from the multiplication of Value x threat x Likelihood x Trajectory. The risk rating was assigned according to the following method:

Low	<80
Medium	< 200
High	< 400
Very High	> 400

Priorities for management actions were determined by the risk rating. High priority actions correspond with very high and high risk ratings. Similarly, medium and low priority

3 Management Objectives, Condition and Values

The regional strategies and policies which are relevant to the Wimmera River Catchment are the:

- Victorian River Health Strategy (2002)
- Draft Wimmera Waterway Management Strategy (2002)
- Wimmera Water Quality Strategy (2002)
- Wimmera River Geomorphic Investigation (2001)
- Geomorphic Categorisation and Stream Condition Assessment of the Wimmera River Catchment (2003)

3.1 Review of State and Regional Strategies

3.1.1. The Victorian River Health Strategy

"The objective of the Victorian River Health Strategy (VRHS) is to achieve healthy rivers, streams and floodplains which meet the environmental, economic, recreational and cultural needs of current and future generations" (DNRE, 2002). To achieve this objective, a management approach based on 4 key elements will be used :

- Protecting rivers that are of the highest community value from any decline in condition;
- Maintaining the condition of ecologically healthy rivers;
- Achieving an 'overall improvement' in the environmental condition of the remainder of the State's rivers, and;
- Preventing damage from future management activities.

Implementation of this management approach will be by:

- Providing special protection for rivers of very high value;
- Establishing regional five and 10 year targets for river protection and restoration through community-driven regional planning processes; and

Establishing policies for specific management activities aimed at preventing damage to river health from future management activities.

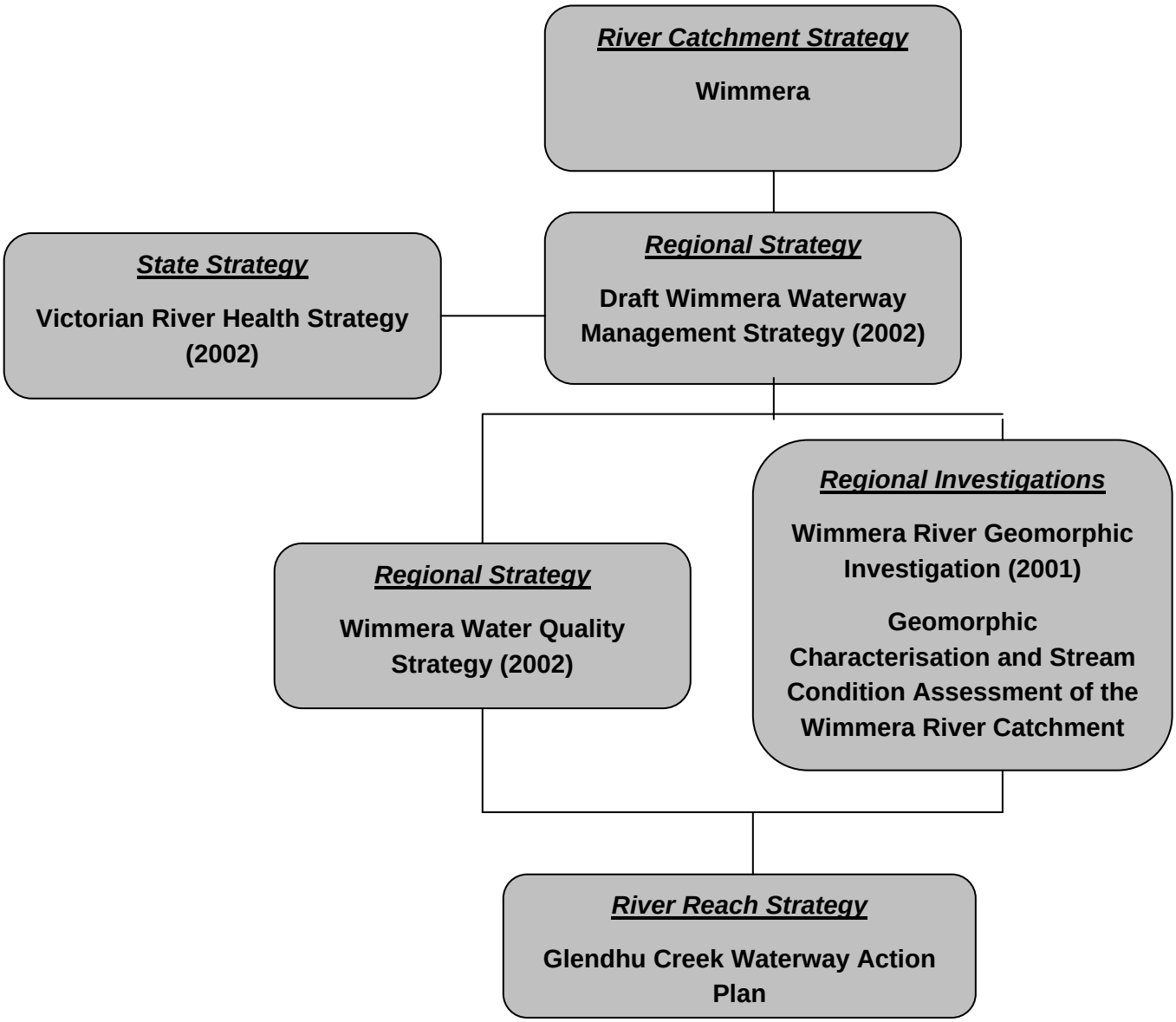


Figure 2 - Relationships between reports used to compile the Glendhu Creek Waterway Action Plan

3.1.2. The Draft Wimmera Waterway Management Strategy

The Wimmera Waterway Management Strategy (WWMS) aims to, *"protect and enhance the region's waterways through fair and sustainable management, taking account of environmental, economic, cultural and social objectives".*

The 2003 Wimmera Regional Catchment Strategy (WRCS) identifies changed channel form as a significant waterway issue and identifies resource condition targets and actions to achieve these.

Key Resource Condition Targets in the Wimmera RCS are:

- R9 – All stream reaches identified as being of high value and in good condition in the Draft Wimmera Waterway Management Strategy be protected by 2020.
- R10 – Improvement in the 'stability condition' of high value streams rated as moderate by the Draft Wimmera Waterway Management Strategy protected or returned to good condition by 2020.

Key Management Action Targets in the Wimmera RCS are:

- WR37 – Undertake works in priority areas to restore and protect in-stream habitat.
- WR50 – Implement priority actions to protect and manage stream forms.
- WR51 – Assist with gully stabilisation where there is a direct impact on the waterway.

A series of programs, which are consistent with the Wimmera Regional Catchment Strategy, are detailed in the WWMS. Of particular relevance to this Waterway Action Plan are:

- Program 1. Asset Management

Aim: To manage structural waterway assets so as to improve the health of the waterways;

- Program 2. Waterway Repair and Maintenance

Aim: To preserve, maintain and/or rehabilitate the environmental, economic and social values of waterways;

- Program 3. Riparian Management

Aim: To improve waterway health through the sustainable management of riparian zones

- Program 4. Catchment Management

Aim: To assist in addressing land management issues that have negative impacts on waterway values.

- Program 5. Flow regimes

Aim: To improve the health of aquatic and riparian ecosystems though provision of appropriate flow regimes, and

- Program 8. Water Quality and Urban Stormwater Management

Aim: To improve the quality of water in the region's waterways and wetlands

The WWMS divided the Wimmera CMA region into 12 Waterway Management Units (WMU). The WMUs are shown in Figure 3. This report aims to confirm and elaborate on the findings of the WWMS in relation to Glendhu Creek which is wholly contained within Waterway Management Unit 2.

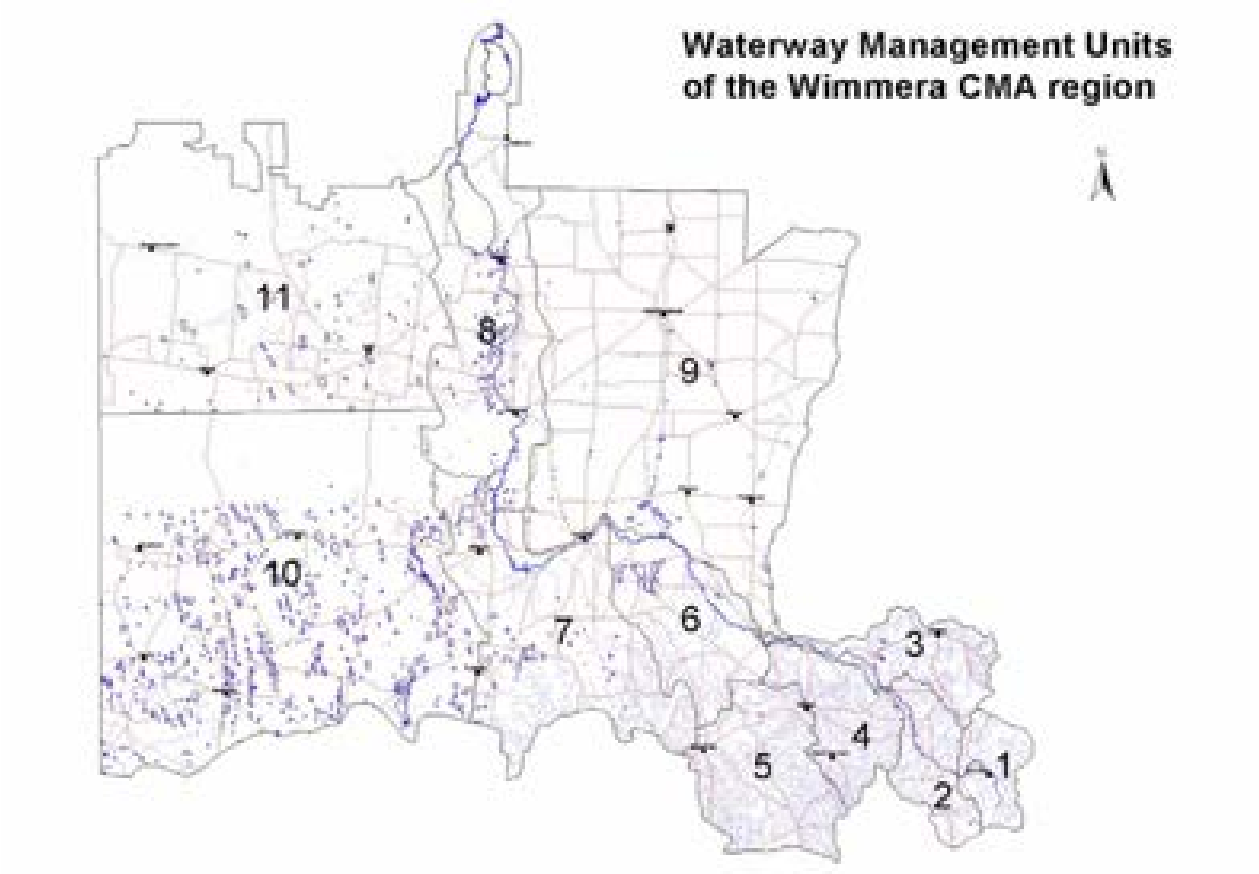


Figure 3 – Waterway Management Units of the Wimmera CMA Region

3.1.3. The Wimmera Water Quality Strategy

"The aim of the Wimmera Water Quality Strategy is to improve the quality of the Region's water that will result in environmental, social and economic benefits to the Region". Implementing the strategy could reduce total phosphorous levels in the Wimmera River by up to 42 tonnes per year (WCMA 2002b).

The strategy is to be applied through a number of Programs. Of these, Program 7; Catchment and River Health Management, is most relevant to this report. Its objective is to, "ensure that catchment and river health management in the region will result in improved water quality". This is to be achieved through:

- Waterway repair and maintenance;
- Flow regimes;
- Riparian management; and
- Catchment management.

3.1.4. The Wimmera River Geomorphic Investigation

The Wimmera River Geomorphic Investigation (WRGI) comprised a review and analysis of sediment processes within the Wimmera catchment, with a focus primarily on the Wimmera River. This report recommends that the following priorities, based on the principles of best practice catchment management, be applied:

- Preserve areas with near pristine values;
- Restore areas of high value;
- Rehabilitate areas that place other values at risk or provide good opportunity for restoring values; and
- Maintain degraded areas to prevent values declining to unacceptable levels.

3.1.5. The Wimmera River Geomorphic Categorisation and Stream Condition Assessment

The Wimmera River Geomorphic Characterisation and Stream Condition Assessment built on previous findings from the Wimmera River Geomorphic Investigation. It identified the stream types throughout the Wimmera River Catchment and provided information to assist in determining management regimes for stream types based on the geomorphic characteristics and condition of the stream. The project identified reference sites for stream types and benchmarked stream condition at those sites. The reference sites are then able to provide a template for rehabilitation of similar stream types elsewhere throughout the catchment.

The report recommended five actions be implemented:

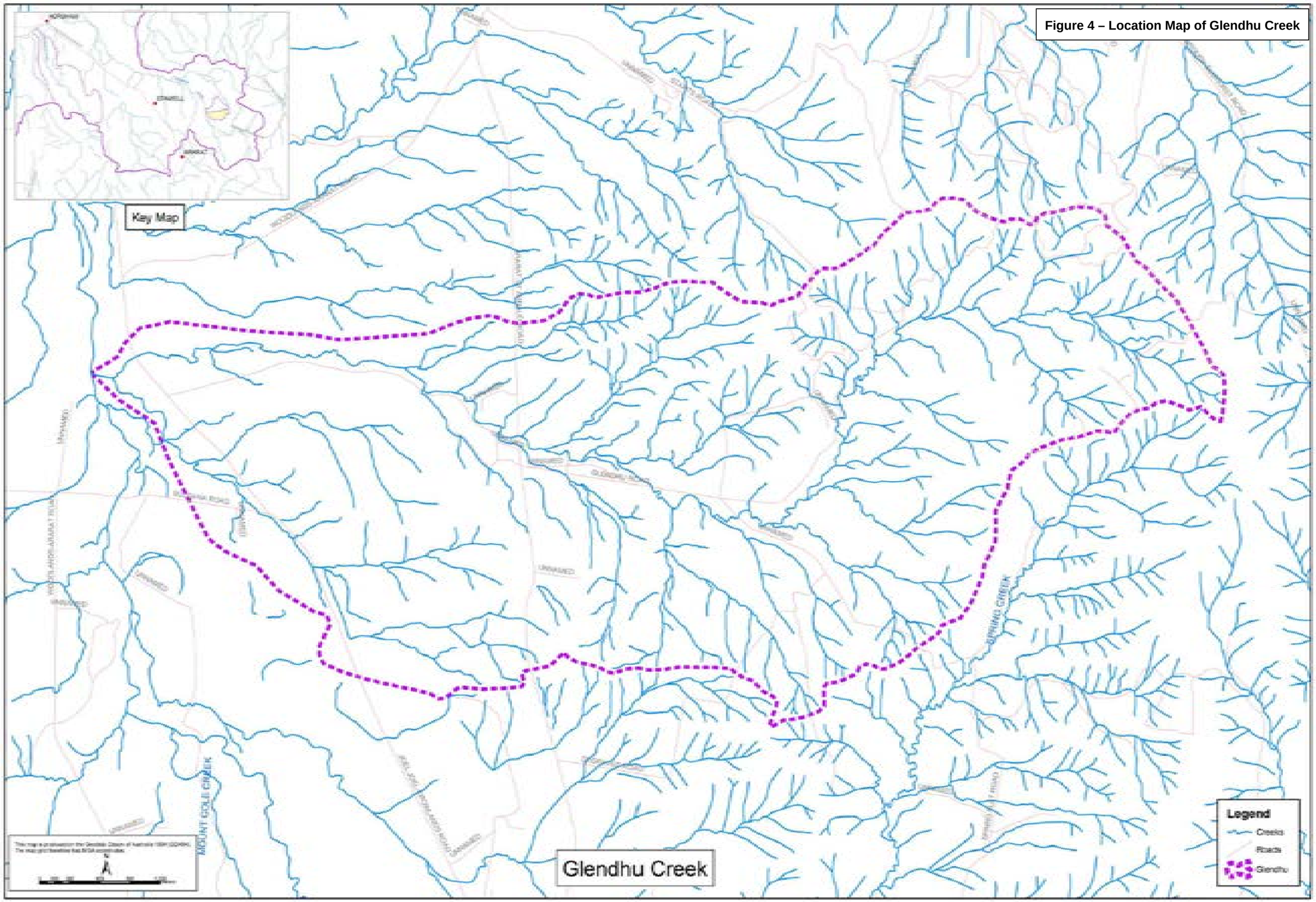
- Protection of Rare Stream Types
- Protection of Streams in Good Condition
- Protection of Stream System Function and Diversity
- Protection of Heritage Rivers
- Defining Template Reaches using Representative Rivers as a Basis

3.2 Glendhu Creek Condition

Glendhu Creek is a highly degraded tributary of the Wimmera River. As part of the Wimmera River Geomorphic Investigation, ID&A (2001) broke down the system into a number of reaches that has different physical attributes and associated stream health issues. Reach 6 of the Wimmera River was defined from just upstream of the junction of Glendhu Creek and the Wimmera River to just downstream of the Joel Joel Bridge. This reach of the Wimmera River is considered to be highly degraded, with excessive sedimentation in the channel zone identified as being the largest problem. The next reach downstream, Reach 7 extends from just below the Joel Joel Bridge to Glenorchy and is considered to be of much higher ecological and geomorphologic value because it has not been affected by excessive sedimentation or other issues.

Glendhu Creek enters the Wimmera River in Reach 6 (see figure 4), and is currently delivering excessively high quantities of sediment to the system. As such, priorities have been put in place to prevent Reach 7 from being affected by degradation issues arising from further upstream. Management of these issues needs to be addressed as close to the source as close as possible (eg: preventing a tributary from depositing large quantities of sediment in the main trunk by attempting to lock it up within the catchment). This is the main management objective for the Glendhu Creek Catchment.

Figure 4 – Location Map of Glendhu Creek



3.2.1. Physical form

Prior to European settlement in the area, it is thought that much of the Glendhu catchment was dominated by a discontinuous channel system, or chain of ponds. Historical channel changes on Glendhu Creek have seen the transformation from a very stable system to one that is highly susceptible to channel change. The catchment has undergone extensive gully erosion, which is still occurring today (ID&A 2001).

"Fresh, mobile deposits of gravel and sand are present at and downstream of its confluence with the Wimmera River. These deposits of sand and gravel are currently found in the bed and on bars and benches of the Wimmera River. Glendhu Creek has direct, unimpeded connections to the river, which is likely to be the main sources of the sediment that is contributing to the observed aggradation problems on the Wimmera River. The likely cause of this degradation is thought to have been the combined effects of catchment clearing and land use change as well as the incision of the Wimmera River initiating headward erosion" (ID&A 2001).

"The major issues perceived include incidences of severe bed and bank erosion and the downstream water quality impacts from sediment and nutrient generation particularly following high flow events. Gully and tunnel erosion are extremely prevalent in these systems. Sheet and rill erosion are also present within the system, but do not exert as much of an impact. There are high grazing pressures on these streams and they are also prone to high levels of salinity" (WCMA 2002a).

"The reduction of soil erosion (particularly gully erosion) in the upper catchment of the Wimmera River system is a key requirement for nutrient reduction. This conclusion is certainly supported by observations made at Glendhu Creek, which carries large quantities of sediment and nutrients directly into the River. In contrast, some other scours in the area may not be so important. Inspections and aerial photograph interpretations indicate that much of the sediment that has been liberated from upper catchment erosion is currently stored in depositional fans in the lower reaches and floodplain areas prior to reaching the river. It is vital that these zones remain stable" (ID&A 2001).

"In the summary of waterway conditions and issues, Glendhu Creek rates poorly for stability condition and very poor for ecological condition. There are high recordings of stream erosion and medium levels of sedimentation and loss of in-stream habitat. There are low issues for pestilent plants with medium concerns for stream vegetation losses, frontage degradation losses and water quality. Glendhu Creek catchment presents high levels of saline groundwater intrusion and catchment erosion salinity" (WCMA 2002a).

3.2.2. Management

"If the objective is to restore the fill of the river valley and possibly a chain of ponds, the contribution of excess sediment loads from tributaries experiencing severe erosion may help accelerate the restoration process. However, it is thought coarse sediment, found in the contemporary bed of the channel does not typify the sediment in chain of ponds stream types, may not be most suitable. The valley fill which forms chains of ponds is generally believed to be finer than sand. That being the case, management of the tributary stream should aim to reduce coarse sediment inputs, while still allowing fine sediment to reach the river. Glendhu Creek is currently delivering all sizes of sediment, including substantial volumes of sand and gravel, which is contributing to the infilling of the river in this reach. If the

management objective is to maintain the continuous channel, these sediment inputs from tributaries will continually work against that objective." Management of the type and quantity of sediment coming into, and out of the catchment, in conjunction with in-stream and riparian vegetation should be able to encourage the regeneration of degraded chain of ponds and fresh water meadows" (ID&A 2001).

"Glendhu Creek has been identified as a system which is delivering coarse sediment to the Wimmera River and stabilisation of the bed is considered to be the highest priority for management intervention. Management strategies should aim to reduce bedload sediment delivery to the river and limit any further headward extension of the gullies. Works to achieve this will be both structural and vegetative. The extraction of sediment from tributaries that are still delivering high quantities of coarse sediment is not recommended as such measures are likely to initiate a new phase of incision and instability" (ID&A 2001).

3.3 Values and Issues in Glendhu Creek

A meeting for relevant stakeholders for Glendhu Creek Catchment was held at the Wimmera CMA offices on June 23rd, 2004. The issues raised at this meeting were;

- *Vegetation management*
- *Erosion control*
- *Location of existing and planned erosion control works*
- *Spread and containment of weeds, particularly Spiny Rush and Serrated Tussock*
- *Fencing and revegetation measures*

A community consultation meeting was also held for Glendhu Creek Catchment at the Crowlands Hall on June 24th, 2004. The issues raised at this meeting were;

- *High rates of erosion (slopes, minor drainage lines and the main trunk stream) – gully erosion seems to be the main problems with many knick points progressing upstream*
- *Sedimentation*
- *Gravel extraction*
- *Stock management*
- *Grazing pressures exerted by kangaroo populations*
- *Significant fencing and revegetation initiatives have been planned and implemented*
- *In conjunction with fencing, significant gully battering, dam construction and construction of drop structures has also occurred in the Glendhu Creek catchment.*

3.4 Waterway Action Plan Objectives

In accordance with State and Regional plans and strategies, the objectives of the Glendhu Creek Waterway Action Plan are;

1. To protect the health and vitality of Glendhu Creek and the health of Reach 7 of the Wimmera River.

   This will involve

   a. determining appropriate actions to manage the current sediment load within Glendhu Creek
   b. assessing the water quality from the Glendhu Creek catchment and its potential impacts on the Wimmera River
   c. assessing the potential for weeds to be transported into the Wimmera River

2. To confirm values and threats identified through existing reports and community consultation and devise appropriate management actions to enhance stream health for the catchment.

3. To develop appropriate management actions on a reach by reach basis, in conjunction with the catchment community.

4 Glendhu Creek Catchment

4.1 Catchment Description

Glendhu Creek is a right-bank tributary of the Wimmera River that originates from steep hill slopes west of the Pyrenees Ranges. The catchment is located approximately 33km east of the township of Stawell, with the Joel-Joel-Crowlands Road being the major traffic thoroughfare through the lower portion of the catchment (see Figure 4, Locality Map). The catchment area is approximately 34 km^2, with changes in elevation ranging from 430m above sea level (ASL) to approximately 250m ASL. Grazing is the predominant land use within the catchment. Landscape changes are likely with the proposed construction of electricity generating wind turbines on the higher ridges of the catchment.

4.1.1. Geology

In the upper portion of the catchment, the geology is mainly sedimentary rock. Conglomerate, dominated by quartz pebbles is the major rock type, with minor outcrops of metamorphic rock also visible. Slow landscape evolution has led to the formation of deeply weathered soils, particularly along the drainage lines. Many of these soils have sodic properties and are highly susceptible to erosion when disturbed. The steeper areas of the upper catchment are currently generating large volumes of sediment as headcuts extend upstream into intact valley fills and the adjacent hill slopes. The majority of first order streams and gullies are eroding and delivering sediment to the trunk stream lines.

The lower portion of the catchment, which comprises flatter valley gradients, consists of Quaternary sediments dominated by sand and silt. Organic-rich soil horizons have been overlain by recent (post-European) deposits of sand and silt sourced from the gully and stream bank erosion in upper parts of the catchment. This erosion is likely to have been initiated by removal of the original vegetation for agricultural purposes.

4.1.2. Geomorphology

Slopes in the upper catchment are steep, ranging between 20 and 35 degrees and the soils are often sodic. As a result of these dispersive soils, sediment from eroding gullies is rapidly transported downstream and most of the drainage lines in the upper catchment are now deeply incised. Many have also widened significantly.

Historical aerial photography collected in the 1940's shows that many of the gullies that were active up to 60 years ago are continuing to erode and generate sediment. Particle sizes in the sediment range from silts and sands through to gravels, all of which have the potential to be easily mobilised due to the steep slopes and high stream powers generated in the main channel of Glendhu Creek.

A lack of in-stream vegetation and bed controls such as bedrock or armouring, has led to incision that provides longitudinal connectivity between the slopes and the confluence of the Wimmera River. This situation is leading to the deposition of large quantities of sediment in the Wimmera River at and immediately downstream of the confluence of the Wimmera River and Glendhu Creek. This mobilised sediment is

infilling the channel of the Wimmera River with a mixture of coarse and fine sediment. The highly mobile fine sediment is further transported downstream into the high value High Value Reach of the Wimmera River.

Historically a number of soil conservation works programs have been carried out with the aim of reducing erosion within the Glendhu Creek catchment. Examples of these works included concrete drop structures, gully plug dams, diversion banks, gully battering, fencing and revegetation with both pasture and tree species. The success of these programs in preventing erosion has been variable, although many have succeeded in stopping the progress of actively eroding gullies. Hard engineered structures are prone to sudden and catastrophic failure as they age, particularly in dispersive soils. Where these have failed, the has result has been a remobilisation of sediment and rejuvenation of headcuts that are eroding upstream along existing drainage lines.

4.1.3. Upper Catchment Geomorphology

In the upper catchment of Glendhu Creek a combination of poor vegetation and the steepness of slopes results in a rapid concentration of rainfall runoff. Short high intensity rainfall events under these conditions have high stream powers that erode bare banks and transport large volumes of all sizes of sediment. Smaller events that occur following a larger event then have the potential to remove (winnow) finer sediment from the bed and deposit it further downstream. This leaves the coarser material in the bed (as lower flow velocities do not have the capacity to mobilise larger sediments), to form an armouring gravel layer. When left undisturbed, this gravel layer has the ability to limit further bed incision. Once bed armouring is established the streambed is less likely to deepen further, and unless otherwise restricted, the channel will undergo a process of widening as illustrated in Figure 5. Examples of active stream widening as a result of this mechanism can be found at a number of locations on Glendhu Creek.

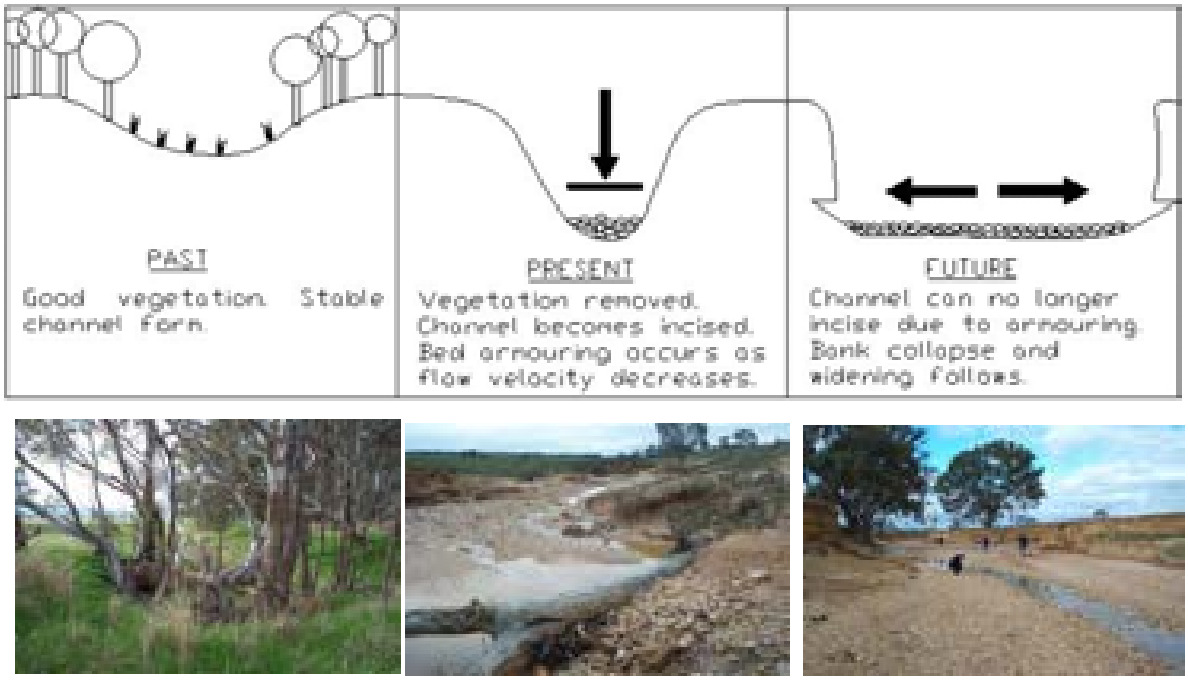


Figure 5. The process of vegetation removal that leads to stream incision and later bed armouring in the upper catchment of Glendhu Creek.

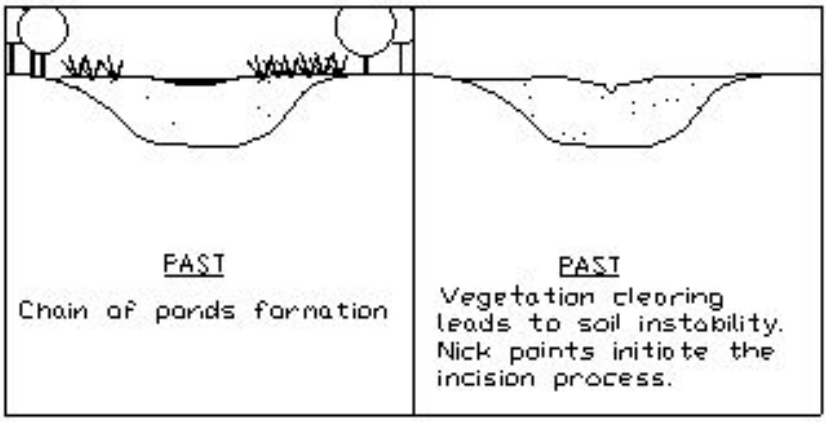
The lack of woody vegetation in the riparian zone, on the rest of the floodplain and surrounding hill slopes, limits the terrestrial habitat values within the catchment. In the steep headwaters of the catchment the ecological in-stream values improve as stock access to the riparian zone is limited by steep bank and channel gradients. Where streamside vegetation has been cleared, the in-stream vegetation has been allowed to grow. This has prevented the incised channel from widening further and has, in places, encouraged the bed elevation of the channel to become raised, reducing the streambed gradient and subsequently reducing the erosive power of water in the channel.

4.1.4. Lower Catchment Geomorphology

At the time of European settlement, a chain of ponds river style dominated much of the lower catchment creek system. Wide scale clearing and in some cases the digging of drainage channels, led to rapid incision and deepening of the streambed. This process has changed the stream from a discontinuous form to a continuous channel that can readily convey sediment to the Wimmera River. The deepening process has stopped where either the bed gradient has become too flat for incision to continue, or where there exists a bed control in the form of bedrock or armouring and/or where there is more sediment than the stream can transport. At these locations the channel has or is undergoing a process of widening. Widening will continue until flow in the over enlarged channel no longer has the capacity to cause further erosion. At this point sediment deposition will lead to the development of instream geomorphic units such as bars and benches. This process is illustrated in Figure 6.

Evidence for the existence of a chain of ponds morphology can be seen in the exposed soil profile at many locations within the walls of the incised channel. This surface is typically black or dark grey and reflects the saturated anaerobic conditions that would have been experienced in the undisturbed system. Many of these surfaces have now been covered, as a result of the incision and erosion process, with a layer of sand and silt, up to 1m thick in some places. In the contemporary condition, there are no remaining examples of the original chain of ponds stream type.

There is very little in-stream vegetation for the large majority of the catchment, and hence very little potential for large woody debris (LWD) recruitment. A lack of LWD has resulted in a channel bed that does not have large pools which would otherwise experience regular localised scouring and deepening during flow events. This, in turn is detrimental to aquatic habitat and water quality, as any pools that may form during a flood event are soon infilled by fine sediments when flow velocities decrease.



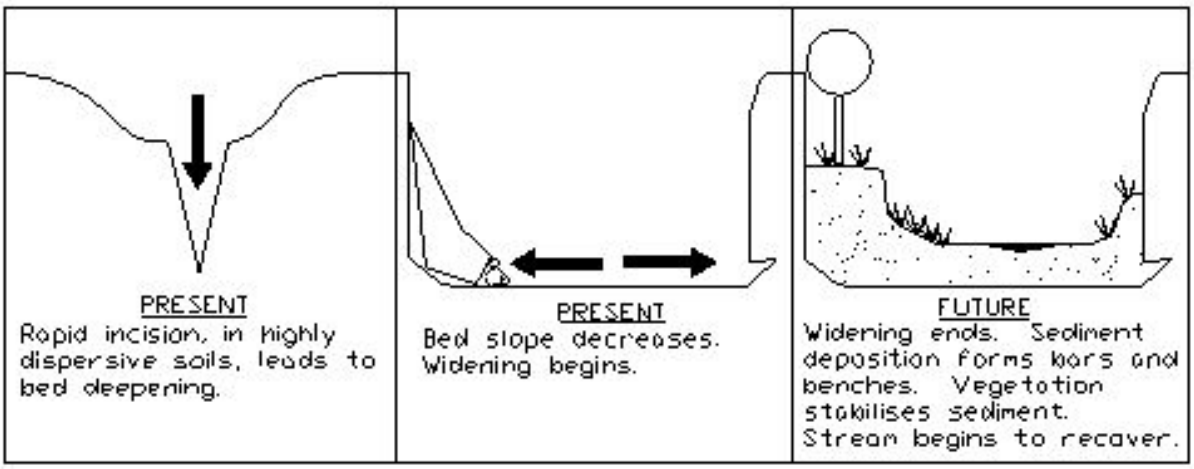


Figure 6. Steps in the process of stream degradation and recovery occurring in the lower reaches of Glendhu Creek.

4.1.5. Vegetation

The native vegetation along the majority of Glendhu Creek is of poor quality. The riparian zone is dominated by exotic pasture species with an overstorey of scattered, mature River Red Gums (*Eucalyptus camaldulensis*). Occasional remnant patches of indigenous grasses and herbs are located where stock access is limited. Shrubs and woody species recruitment is absent along most of the stream frontage and on the adjacent floodplain. The quality and abundance of indigenous vegetation remnants improves in the upper reaches of the catchment.

4.1.6. Habitat Quality

A widespread lack of riparian vegetation in good condition decreases the overall habitat quality of the Glendhu Creek catchment to Low.

4.2 Waterway Management Targets

In order for the management actions proposed in the Glendhu Creek Waterway Action Plan to contribute to the achievement of Statewide River Health Targets (see Table 3), the following waterway management targets for Glendhu Creek have been developed. These targets are the basis on which the proposed works are prioritised:

1. Progressively reduce the amount of sediment originating from Glendhu Creek and subsequently entering the Wimmera River. Measuring achievement of this target through monitoring sediment input from the Glendhu Creek at its confluence with the Wimmera River is difficult. Improvements in bed and bank stability, measured as part of Index of Stream Condition Assessments, may be used to extrapolate decreased sediment inputs.
2. Achieve an average Index of Stream Condition rating of 'Moderate' throughout the catchment.

Although ISC assessments have not been undertaken, it is expected that ISC ratings for Glendhu Creek would be poor or very poor. An improvement in the ISC rating results from an increase in the 5 sub index scores which comprise ISC ratings. These sub indices are hydrology, physical form, streamside zone, water quality and aquatic life. Increases in scores of the sub indices indicate improving stream health. All management actions within the Waterway Action Plan are aimed at increasing the sub index scores. Of particular note, within Glendhu Creek, is the need to improve habitat quality over the whole reach. Inturn, habitat quality improvement will result in an improvement of the streamside zone and physical form within the Glendhu catchment, and an improvement in water quality within Glendhu Creek and the Wimmera River, thereby lifting the ISC score. A minimum score of 'Medium', based on the modified Habitat Hectares assessment method is an achievable target within the Glendhu catchment. Protecting intact valley fills of Glendhu Creek is important in order to protect hydrologic regimes and the physical form of the stream. Protecting intact valley fills will assist in retarding runoff and reducing stream powers.

Due to the poor overall condition of the creek, it is expected that a long term (up to ten years) works program will need to be implemented to achieve these management targets. Higher targets, greater effort and longer timeframes would be required if higher habitat/connectivity targets were sought.

Table 3. Statewide River Health Targets relevant to the Glendhu Creek.

By 2011:

- *4800 of rivers with improvement of one rating in the measurement of riparian condition*
- *an increase of 7000 hectares of riparian areas under management agreements*
- *600 km of rivers where instream habitat has been reinstated*
- *60% of all lowland monitoring sites will meet SEPP environmental quality objectives*
- *1000 high value public assets provided with appropriate level of protection*

4.3 Options for Waterway Management

There are a large number of techniques that can and have been successfully used in undertaking the repair and protection of land and waterways. Each of these techniques has its own advantages and disadvantages, and in the upper Wimmera catchment, many of these techniques have been and continue to be used. Among the methods applied are:

Concrete chutes	Drop structures
Fencing and revegetation	Gully battering
Gully plug dams	Grass chutes
Rock chutes	Rock beaching
Timber pile fields	Trickle pipes

In considering appropriate management actions for Glendhu Creek, it is recognised that many of the above techniques may be applicable. Options for management have been determined based on providing the most cost effective solution. Costs for the actions recommended in this report are included in section 11 to allow comparison with other solutions.

5 Management Reaches

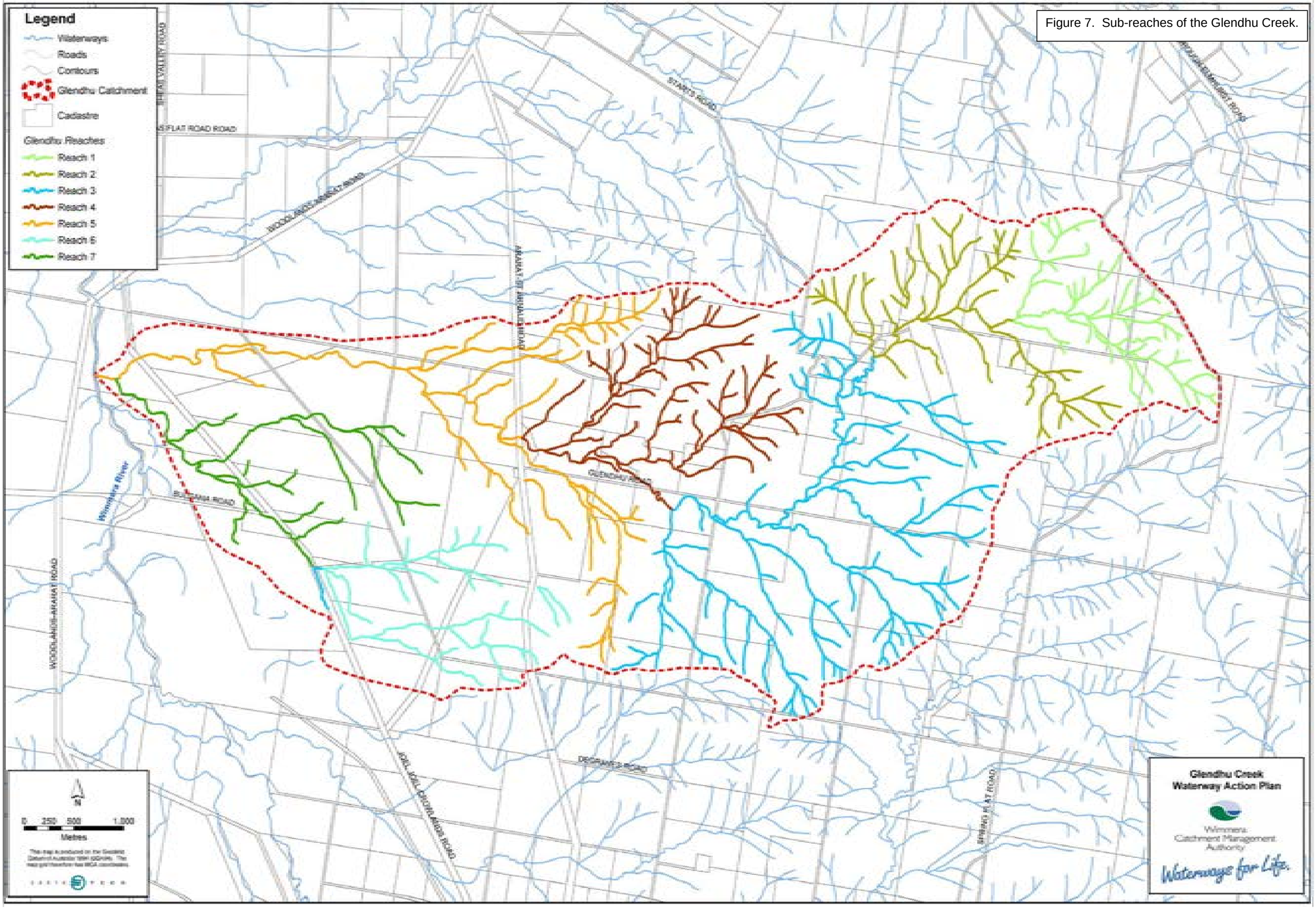
For ease of management and in order to refine the assessment process and works program, Glendhu Creek has been divided into seven reaches. This delineation has been based on the geomorphic processes currently occurring within each reach. The decision to divide the catchment on geomorphic grounds is based on the premise that geomorphology determines the form of the creek and therefore has a major influence on vegetation and habitat values within any particular reach. The location and extent of each reach is shown on Figure 7, with the Easting and Northing of the reach delineators listed in Table 4.

Table 4: Reach delineation of Glendhu Creek.

Reach	Location
Reach 1	Headwaters of Glendhu Creek to tributary junction at E 691 636 N 5 893 360.
Reach 2	Tributary junction at E 691 363 N 5 893 360 to tributary junction at E 690 250 N 5 892 962
Reach 3	Tributary junction at E 690 250 N 5 892 962 to Glendhu Road crossing
Reach 4	Glendhu Road crossing to Ararat - St Arnaud Rd
Reach 5	Ararat - St Arnaud Rd to junction of Wimmera River
Reach 6	Major southern tributary. Upstream of Joel Joel - Crowlands Road.
Reach 7	Major southern tributary. Downstream of Joel Joel - Crowlands Road.

Appendix A shows the location of each reach on a longitudinal section of the main trunk of Glendhu Creek. Bedslope information for these drawings has been determined by using the ten metre contour interval from a topographic map of the catchment. As stream bedslope plays a major role in geomorphic processes, illustrating reach delineation in this manner allows a rapid appraisal of potential locations of geomorphic change.

Figure 7. Sub-reaches of the Glendhu Creek.



5.1 Reach 1: Headwaters of Glendhu Creek to tributary junction (E 691 363, N 5 893 360)

5.1.1. Geomorphology

Reach 1 is characterised by drainage lines that are well defined but not incised as the slopes have very shallow soils underlain by rock. At the base of the steep slopes, the gradient is considerably flatter, and as such the valley floor acts as a sediment sink. At these locations, sediment is deposited in small fans, which currently have minor isolated headcuts extending back upstream. They are, however, still considered to be intact valley fills, representative of the original landscape and therefore considered to be of high intrinsic value within the catchment.

The headwaters are at an elevation of approximately 360m ASL (AHD), and the creek drops about 20m over a distance of 1,060m to the tributary junction. The average gradient over this Reach is 0.019 (1:53).

5.1.2. Vegetation

The upper slopes of the Glendhu Creek catchment are mostly well vegetated despite the steep terrain and rocky soils. Pre 1750s EVC mapping indicates that vegetation in this reach was once dominated by Grassy Dry Forest. This EVC is characterised by a Eucalyptus overstorey comprised of Red Stringybark (*E. macrorhyncha*), Red Box (*E. polyanthemos*), Yellow Box (*E. melliodora*) and Bundy (*E.goniocalyx s.s.*). Understorey shrubs include Hedge Wattle (*Acacia paradoxa*), Drooping Cassinia (*Cassinia arcuata*), Gorse Bitter-pea (*Davesia ulicifolia*) and Gold-dust Wattle (*Acacia acinacea s.l.*). Ground layer species include Wattle Mat Rush (*Lomandra filiformis*) and various Spear Grasses (*Austrostripa* sp.), Grey Tussock-grass (*Poa sieberiana*) and Wallaby Grasses (*Austrodanthonia* sp.).

Following European settlement, this area was, and continues to be grazed. Some remnant patches of Grassy Dry Forest exist on steep hillslopes where grazing and pasture improvement works have been less intensive. **The Dry Grassy Forest EVC is listed as 'depleted' in the Goldfields Bioregion and action should be taken to protect and enhance these remnant vegetation areas.**

5.1.3. Reach 1: Threats and Risks

Threat	Risk
Active erosion of sediment fans in the lower sections of the reach where flatter gradients have previously allowed deposition to occur. Potential for large quantities of sediment to be mobilised.	High
Active and uncontrolled transportation of in-stream sediment.	High
Erosion of the steeper slopes. Hill slope vegetation and shallow soils limit the potential for major damage.	Moderate
Widening of the channel – particularly through the fans (natural process after incision).	Moderate
Smothering of in-stream vegetation by mobilised sediment.	Moderate

Management Actions and Cost estimates determined for Reach 1 are detailed in section 11. Works locations are shown in Appendix E.

5.2 Reach 2:

Tributary junction (E 691 363,N 5 893 360) to Tributary junction (E690 250,N 5 892 962)

5.2.1. Geomorphology

The channel at this location within the catchment is largely controlled by the valley gradient and alignment, and therefore has minimal capacity to actively migrate across the floodplain. The bedload is gravel-based. There are some sandy, more stable sections where pools form, as evidenced by a small stand of macrophyte species. The bed profile is stepped, with bedrock and gravel riffles separating shallow pools. Sediment stores contained within intact valley fills in the upstream reach have the potential for mobilisation, with minor headcutting already evident. This poses a threat to the pools and geomorphic form of Reach 2. However, due to the steep gradient of the channel, it is unlikely that sediment from the upstream reach will be trapped and retained in this reach. Rather, it will be transported through the reach and deposited further downstream. During this process the existing pools will be filled with sediment.

The main trunk in this reach is deeply incised. The creek has not widened, and instead has formed a steep-sided, U-shaped channel. The banks are too steep and deep for stock to gain access to the channel bed. This has allowed a good cover of vegetation to colonise and stabilise the bed and banks of the channel.

The right bank has a higher density of tributary channels than the left bank. Tributaries are poorly vegetated and are therefore actively eroding previously intact valley fill and slope material.

This Reach is steeper in the upper portion with an overall average grade of 0.014 (1:72) (see App A)

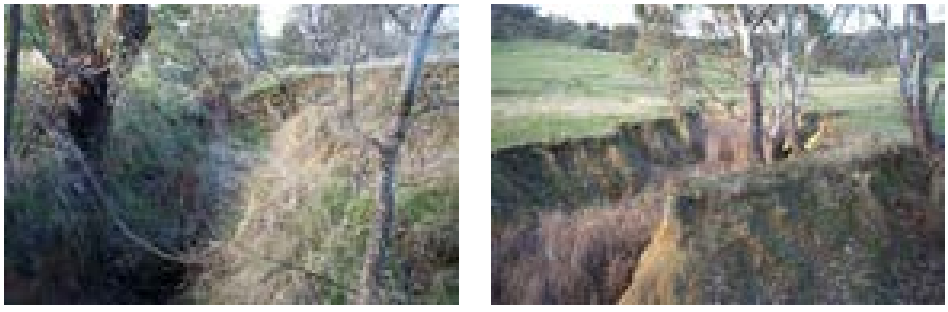


Figure 8. A well vegetated stream channel and minor gully erosion in Reach 2 of Glendhu Creek (August 2004).

5.2.2. Vegetation

Pre 1750s EVC mapping indicates that vegetation in Reach 2 was dominated by Grassy Dry Forest. This area is currently grazed by stock. Some remnant patches of indigenous vegetation and scattered trees are evident where grazing and pasture improvements have had less of an impact such as in gullies and drainage lines.

Two vegetation assessments were completed in this reach due to the variability in remnant communities. Site 1 is located in a sheltered area on the main stem of the Glendhu Creek. The gully is rich in ground layer species, including a rare Wallaby Grass, (*Austrodanthonia bipartita*), Slender Speedwell (*Veronica gracilis*) and features Wattles in the mid storey such as Lightwood (*A. implexa*), Black Wattle (*A. mearnsii*) and Blackwood (*A. melanoxylon*).

Site 2 is also located on the main stem of the Glendhu Creek. The site features an uncharacteristic occurrence of Eurabbie (*E. globulus* ssp. *bicosata*). This species is usually found in high rainfall areas such as in the head-waters of the Wimmera River. Good species diversity in the ground layer and occasional shrubs in the mid storey such as Black Wattle (*A. mearnsii*) are also present. Direct seeding of native species has failed at this site, possibly because stock were not excluded prior to vegetation becoming established. The few plants that have survived are currently being grazed by stock.

5.2.3. Habitat Quality

The quality of the habitat in this reach was assessed at two representative locations using the RHA method. Table 5 details the result of this assessment.

Table 5. Habitat quality assessment for Reach 2.

Site Nr.	Preliminary Score	Habitat Quality
1	10	Medium
2	4	Low

Note: 0-6.5 = Low Habitat Quality, 7-11.5 = Medium Habitat Quality, 12-20 = High Habitat Quality

5.2.4. Threats and Risks

Threat	Risk
Highly active and uncontrolled transportation of in-stream sediment (gravel).	High
Widening of the channel – particularly through the fans (this is a natural process following incision).	Moderate
Loss of in-stream vegetation.	Moderate

Management Actions and Cost estimates that have been determined for Reach 2 are detailed in section 11. Works locations are shown in Appendix E.

5.3 Reach 3: Tributary junction (E 690 250, N5 892 962) to Glendhu Road crossing

5.3.1. Geomorphology

The valley margins, terraces and channel gradient largely control the channel behaviour in Reach 3. Lower channel gradients, due to position in the catchment, have led to the accumulation of floodplain sediment in Reach 3. Pond deposits and organic-rich soil horizons present in the exposed banks of the floodplain are testament to the lower channel capacities and generally moist conditions that would have existed in the catchment prior to European settlement. Continuous floodplain is now currently found on both banks for a large majority of the reach, with the channel having a very sinuous (meandering) alignment. Moderately steep gradients and high sinuosity means that the system still has the ability to erode its bed and banks. This is occurring at a number of isolated bends, with some banks having recently failed. However, reasonably high channel capacities and a well-armoured gravel bed mean that there is little, if any, potential for the channel to continue on this path. Reach 3 is currently acting as a minor sediment source zone, but is primarily a sediment transfer/deposition zone. Gravel bars and benches are forming in the bed of the channel with a low flow channel adopting a sinuous alignment around them. If stock were to be excluded from the channel zone, Reach 3 has good potential for revegetation. This will stabilise the bed by trapping and holding of sediment, and therefore decreasing the amount of sediment that passes through this reach.

Reach 3 has an overall average grade of 0.008 (1:130), but is slightly steeper in the upper part, gradually tapering off downstream. (see App A)

Figure 9. Evidence of sediment deposition with in Reach 3 (August 2004).

Tributaries entering Reach 3 are very degraded with bare banks and quite poor riparian vegetation. Tributaries such as these are delivering large quantities of sediment to the main trunk of the Glendhu Creek. This sediment is then transported further downstream. A number of the tributaries have been battered and sown with pasture. Some of these are now beginning to re-incise and without intervention the gully initiation process is likely to begin again.

5.3.2. Vegetation

Pre 1750s EVC mapping indicates that creekline vegetation in this reach was once dominated by Alluvial Terraces Herb Rich Woodland. This EVC is characterised by a Eucalypt overstorey comprised of Grey Box (*E. microcarpa*), Yellow Box (*E. melliodora*), Yellow Gum (*E. leucoxylon*) and Buloke (*Allocasuarina luehmannii*). Understorey shrubs include Golden Wattle (*A. pycnantha*), Gold-dust Wattle (*A. acinacea s.l.*), Hedge Wattle (*A. paradoxa*), and Spreading Wattle (*A. genistifolia*). Ground layer species include Smooth Solenogyne (*Solenogyne dominii*), Wattle Mat-rush (*Lomandra filiformis*), Common Wheat Grass (*Elymus scaber* var. *scaber*), Black-anther Flax-lily (*Dianella revolute s.l.*) and various Spear Grasses (*Austrostripa* sp.).

The contemporary vegetation in this reach is dominated by exotic, annual species. Native species diversity is limited in this reach and stock currently graze the riparian zone. Very occasional patches of remnant indigenous grasses and shrubs are found beneath scattered, over-mature Red Gums (*E. camaldulensis*). Native species are not regenerating. An unknown *Carex* sp. was found in the bed of this reach.

5.3.3. Habitat Quality

One habitat quality assessment was completed in this reach, the results of which are shown in Table 3 This site has large trees, adequate canopy cover and some understorey species. Recruitment is low and litter and logs are below benchmark levels. Exotic species occupy more than 50% of the canopy cover.

Table 6. Habitat quality assessment for Reach 3

Site Nr.	Preliminary Score	Habitat Quality
1	5	Low

Note: 0-6.5 = Low Habitat Quality, 7-11.5 = Medium Habitat Quality, 12-20 = High Habitat Quality

5.3.4. Threats and Risks

Threat	Risk
Excess sediment input/transfer through the reach.	High
Widening of the channel (a natural process following incision).	Medium
Smothering of in-stream vegetation by mobilised sediment.	Medium
Continuing incision and sediment mobilisation/transport in the tributary streams.	High

Management Actions and Cost estimates have been determined for Reach 3. They are detailed in section ll. Works locations are shown in Appendix E.

5.4 Reach 4: Glendhu Road crossing to the Ararat - St Arnaud Rd

5.4.1. Geomorphology

The width of the valley floor in Reach 4 is considerably larger than those upstream. This is reflected by lower channel gradients and larger volumes of sediment stored within the floodplain. The channel has a moderate to high sinuosity, however, it also has a larger channel capacity than Reach 3. This larger channel capacity and land management practices in the downstream reach, have led to the conclusion that a gravel extraction operation may have been undertaken in sections of Reach 4. No extraction is currently occurring and as such sediment is accumulating in the reach, forming bars and benches. The low flow channel is subsequently adopting a sinuous alignment around the bars and benches. The final 200m of the reach, just upstream of the road is very well vegetated. This has prevented the channel from widening and has reduced the potential for further erosion.

Many of the tributaries entering Reach 4 have bare banks, are actively eroding, and are depositing large quantities of sediment into the main trunk. Some of these have previously been battered and sown with pasture. However, they are now beginning to re-incise and the gully initiation process will begin again. Some of the gully battering that has previously been done is successful and it is thought that a combination of bank diversions, gully plug dams and revegetation using woody species is contributing to the success of these projects.

Reach 4 has an average grade of 0.01 (1:100) with the middle portion of the reach slightly steeper than the upstream and downstream portions. (see App A)

Figure 8. The view upstream and downstream from the Ararat-St Arnaud Road crossing. Note the volume of coarse sediment within the channel (August 2004).

5.4.2. Vegetation

Pre 1750s EVC mapping indicates that vegetation in this reach was also once dominated by Alluvial Terraces Herb Rich Woodland. Today vegetation in this reach is similar to that in Reach 3 and is dominated by exotic, annual species.

Native species diversity is limited and stock currently graze the riparian zone. Very occasional patches of remnant indigenous grasses and shrubs are found beneath scattered, over-mature Red Gums (*E. camaldulensis*). Native species are not regenerating.

5.4.3. Habitat Quality

Habitat Quality assessments were undertaken where sections of the stream were representative of stream condition. Upon delineation of stream reaches for management purposes, some reaches did not have an assessment undertaken within them.

A habitat quality assessment was not undertaken in Reach 4. Habitat quality is expected to be low within this reach.

5.4.4. Threats and Risks

Threat	Risk
Excess sediment input/transfer through the reach	High

Management Actions and Cost estimates have been determined for Reach 4. They are detailed in section 11. Works locations are shown in Appendix E

5.5 Reach 5: Ararat - St Arnaud Rd to Confluence of Wimmera River

5.5.1. Geomorphology

Reach 5 in the Glendhu Creek catchment is in a highly degraded state. Due to its downstream position within the catchment, this reach is a natural sediment accumulation zone. It has a flatter grade than all the upstream reaches with an average grade of 0.006 (see App A). However, a gravel extraction operation throughout much of Reach 5 is impacting on the natural tendency for the streambed and banks to stabilise.

Large scale sediment extraction significantly increases sediment mobilisation through the rejuvenation of instream headcuts which then extend back upstream. As a result, the channel upstream deepens which in turn leads to stream widening through the process of bank collapse. The sediment generated is then mobilised in the next flow event and moves through the extraction site, affecting downstream reaches of the creek. The series of figures and photos that follow (Figure 11a, b, c, d and e) illustrate this de-stabilising effect of sediment extraction. The presence of a three box culvert road crossing on the Ararat-St Arnaud Road, is acting to limit the upstream extent of the de-stabilising effect of the gravel extraction operation.

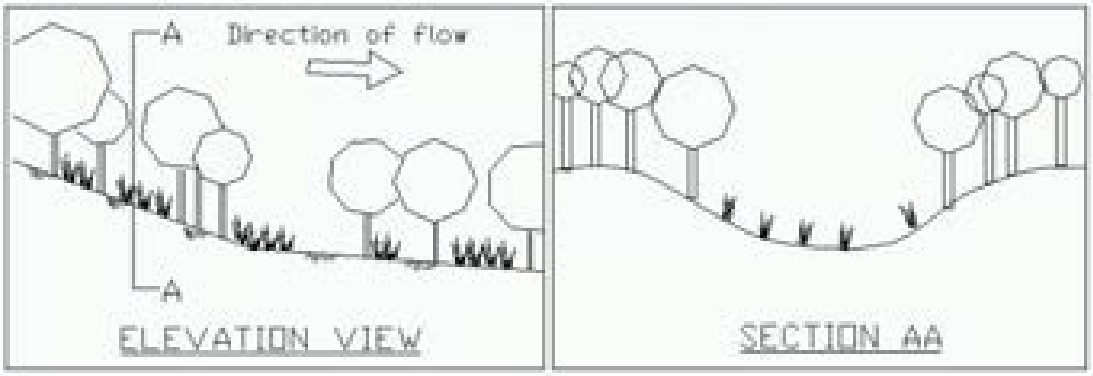


Figure 11a. Waterway conditions prior to vegetation clearing.

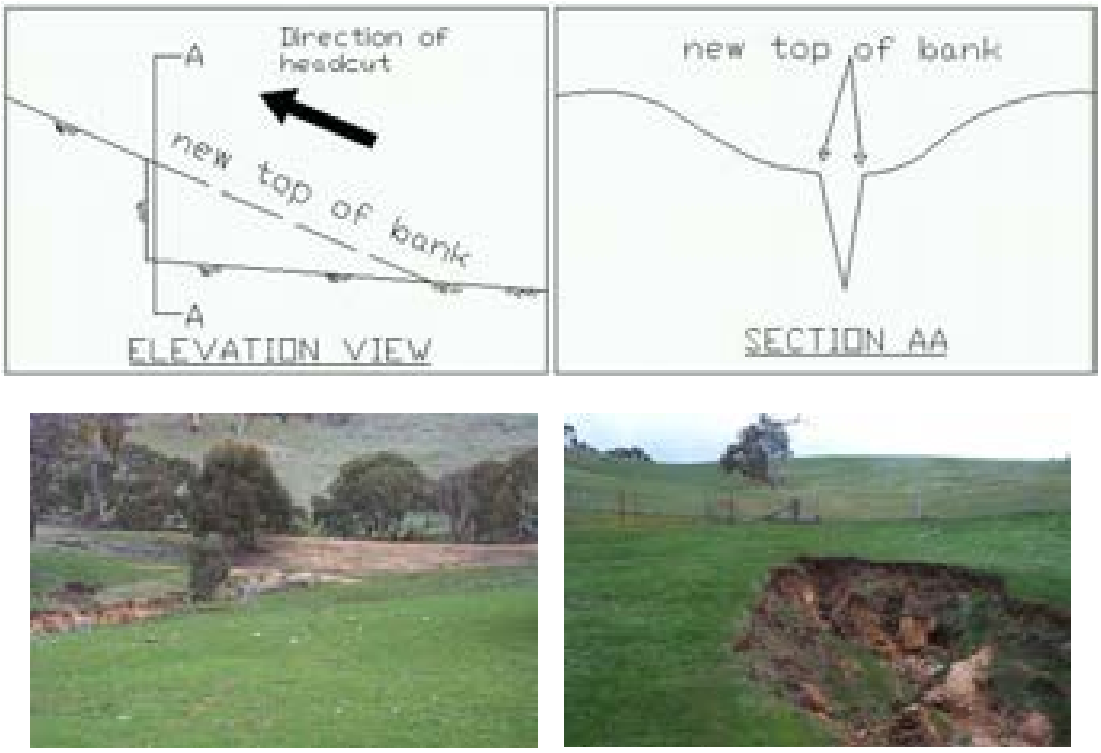


Figure 11b. Waterway conditions following vegetation clearing. Incision begins.

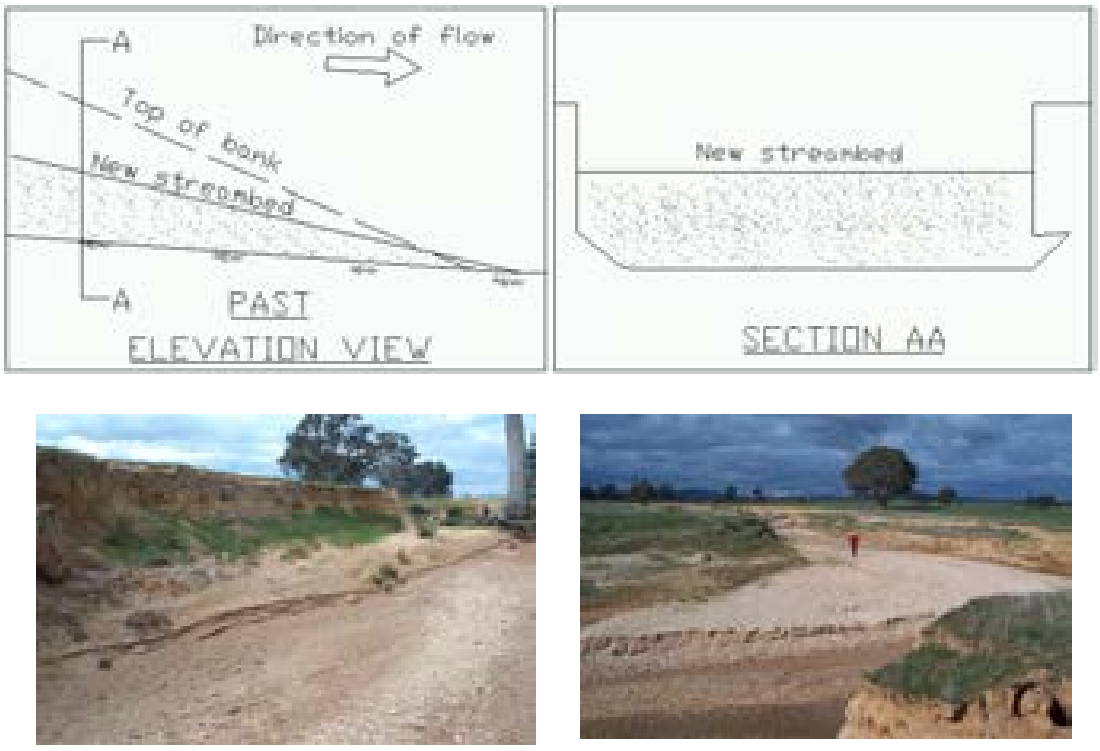


Figure 11c. Incision and widening stops. Sediment from upstream fills the streambed and the stream begins to recover.

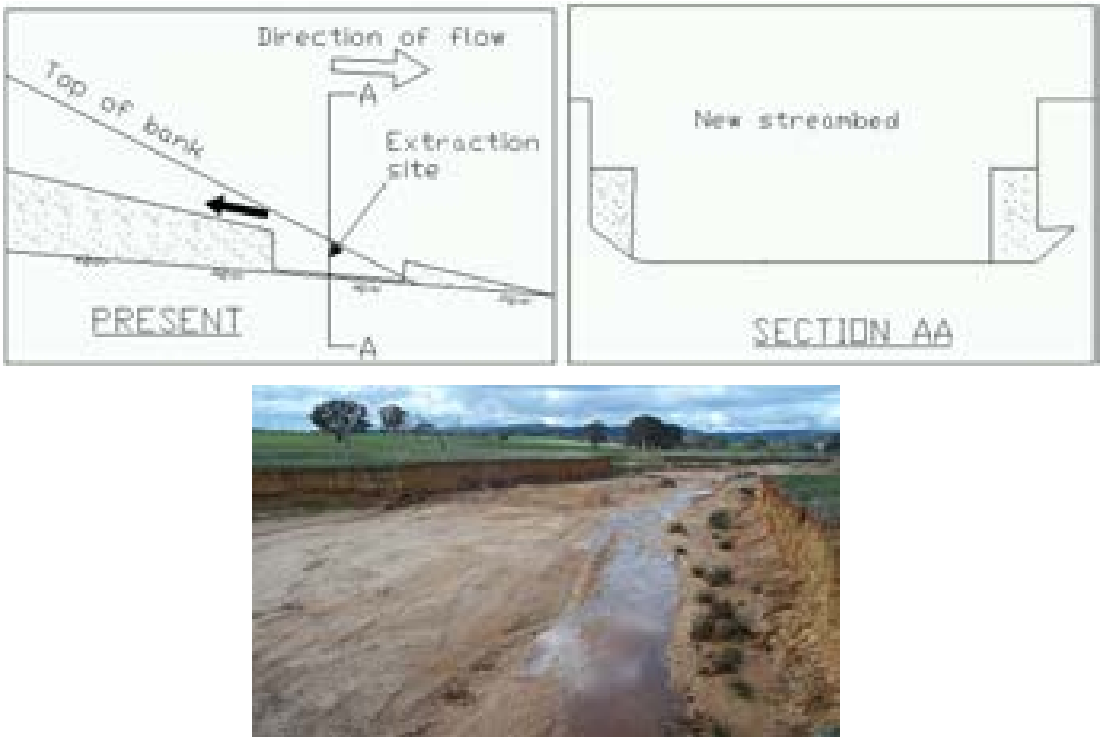


Figure 11d. Sediment extraction causes deepening in a localised section of streambed. This results in a sudden change in bed level at the upstream end of the extraction site, which in turn leads to headward erosion into the upstream reaches of the stream.

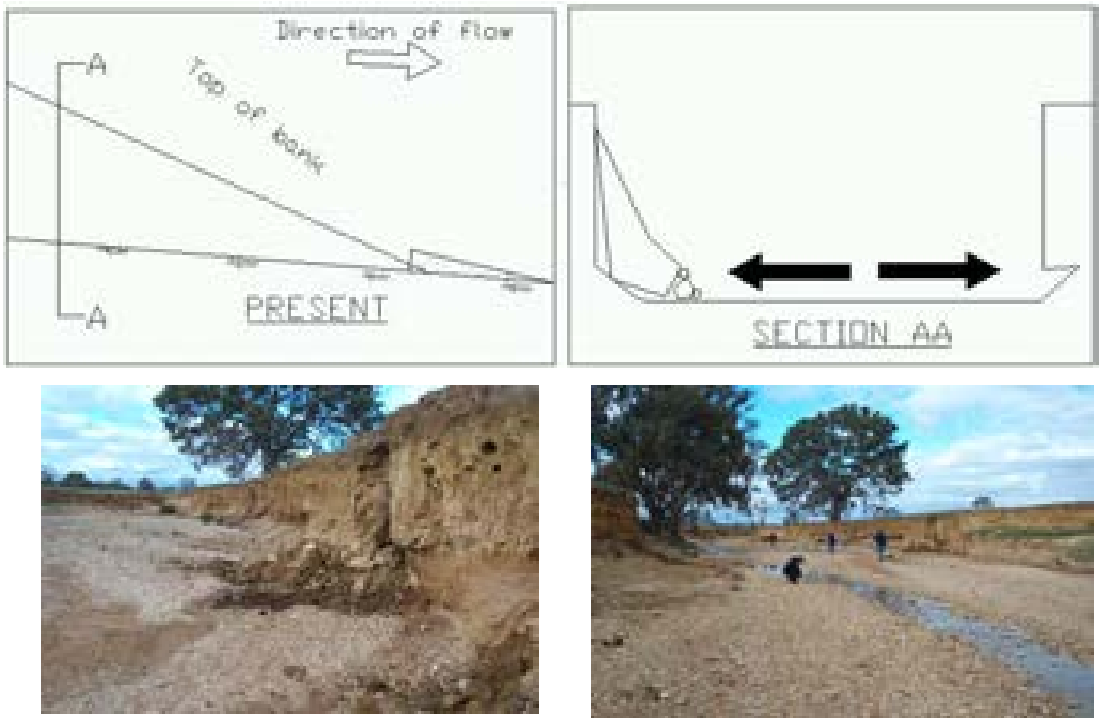


Figure 11e. Bed deepening upstream causes bank collapse and stream widening, leading to a loss of land and the generation of large volumes of sediment.

The lower section of the reach is poorly vegetated within the channel. This lack of vegetation is allowing large volumes of sediment to be easily transported through the reach and into the Wimmera River.

5.5.2. Vegetation

Pre 1750s EVC mapping indicates that vegetation in this reach was once dominated by Creekline Grassy Woodland. Creekline Grassy Woodland features an overstorey of Grey Box (*E. microcarpa*), River Red Gum (*E. camaldulensis*) and Yellow Box (*E. melliodora*). Understorey species include Golden Wattle (*A. pycnantha*), Gorse Bitter-pea (*Davesia ulicifolia*), Drooping Cassinia (*Cassinia arcuata*), Common Tussock-grass (*Poa labilliardierei*) and Weeping Grass (*Microlaena stipoides).*Vegetation in this reach is now dominated by exotic, annual species.

Native species diversity is moderate and includes aquatic and semi-aquatic species such as Water Ribbons (*Triglochin striata*), Cumbungi (*Typha* sp.) and *Carex* sp. Occasional patches of remnant grassland including species such as Kangaroo Grass (*Themada triandra*), Tussock Grass (*Poa* sp.), Spear Grasses (*Austrostipa* sp.) and Wallaby Grasses (*Austrodanthonia* sp.) are found beneath scattered, over-mature Red Gums (*E. camaldulensis*). One rare species, Corkscrew Spear Grass (*Austrostipa setacea*) was found upstream from the Crowlands Joel Joel Rd bridge. Very little recruitment of native woody species is occurring.

5.5.3. Habitat Quality

Three habitat quality assessments were completed in this reach. The results of these are listed in Table 5.

Table 7. Habitat quality assessment for reach 5

Site Nr.	Preliminary Score	Habitat Quality
1	5	Low
2	6	Low
3	2	Low

Note: 0-6.5 = Low Habitat Quality, 7-11.5 = Medium Habitat Quality, 12-20 = High Habitat Quality

5.5.4. Threats and Risks

Threat	Risk
Gravel extraction causing sediment starvation will cause the low flow channel to constantly alter its alignment. This will in turn increase erosion rates of both the bed and the banks. This process is currently happening, and will continue to do so if gravel extraction continues.	High

Management Actions and Cost estimates for Reach 5 are detailed in section 11. Works locations are shown in Appendix E.

5.6 Reach 6: Southern tributary. Upstream of Joel Joel - Crowlands Road.

5.6.1. Geomorphology

Reach 6 is dominated by a broad, low-gradient valley that is well vegetated with pasture grasses. As a result, it has experienced little, if any headward incision. The channel is poorly defined and it is likely that much of the catchment took this form prior to European settlement. This reach is therefore considered to have high intrinsic value and is a site that should be preserved. A drop structure approximately 3m high on the downstream side of the Joel Joel-Crowlands Road and another small structure approximately 0.5m high on the upstream side of the road have prevented any headward incision from migrating upstream through the reach.

Figure 12. A small drop structure and remnant vegetation alongside the Joel Joel-Crowlands Road. The photo on the right shows a minor headcut in this reach (August 2004).

5.6.2. Vegetation

Pre 1750s EVC mapping indicates that vegetation in this reach was also once dominated by Alluvial Terraces Herb Rich Woodland and Low Rises Grassy Woodland and Grassy Dry Forest further up the catchment. Low Rises Grassy Woodland is characterised by a Eucalyptus overstorey comprised of Grey Box (*E.microcarpa*) and Yellow Gum (*E. leucoxylon*). Understorey shrubs include Drooping Cassinia (*Cassinia arcuata*), Golden Wattle (*Acacia pycnantha*), Gold-dust Wattle (*Acacia acinacea s.l.*) and Wedge-leaf Hop-bush (*Dodonaea viscosa* ssp. *cuneata*). Ground layer species include Stinking Pennywort (*Hydrocotyle laxiflora*), Grey Tussock-grass (*Poa sieberiana*), various Spear Grasses (*Austrostripa* sp.) and Wallaby Grasses (*Austrodanthonia* sp.).

Vegetation in this reach is now dominated by exotic, annual species. Native species diversity is limited in this reach and stock currently graze the riparian zone. Very occasional patches of remnant indigenous grasses and shrubs are found beneath scattered, over-mature Red Gums (*E. camaldulensis*). Native species are not regenerating.

In this area large trees are scattered, canopy cover is reduced and very little understorey is present. Exotic species are in abundance while logs, recruitment and organic litter are virtually absent.

5.6.3. Habitat Quality

Habitat Quality assessments were undertaken where sections of the stream were representative of stream condition. Upon delineation of stream reaches for management purposes, some reaches did not have an assessment undertaken within them.

A habitat quality assessment was not undertaken in Reach 6. Habitat quality is expected to be low within this reach.

5.6.4. Threats and Risks

Threat	Risk
Headcut incision from downstream	Low

Management Actions and Cost estimates have been determined for Reach 6 and are detailed in section 11. Works locations are shown in Appendix E.

5.7 Reach 7: Southern tributary. Downstream of Joel Joel - Crowlands Road.

5.7.1. Geomorphology

Immediately downstream of the Joel Joel Road is a 3m high concrete drop structure that is preventing any further incision that may extend into Reach 6 upstream of the road. Below the road crossing, the stream runs parallel to the road and is incised with bare banks. Due to the relatively low gradient in the reach, there is little active erosion of either the bed or the banks of the channel. As the channel progresses downstream, the channel capacity decreases. This is thought to be in-part controlled by the old railway line that has been raised above the level of the floodplain. Part, or all, of this reach may have been modified and channelised in a similar fashion to the contemporary channel in Reach 5 upstream of the drop structure. Low gradients and sediment deposited from both the Wimmera River and Glendhu Creek may be infilling the pre-existing channel.

Figure 13. A relatively stable gully upstream of the Joel Joel-Crowlands Road and sediment deposition downstream of the Joel Joel-Crowlands Road in Reach 7 (August 2004).

5.7.2. Vegetation

Pre 1750s EVC mapping indicates that vegetation in this reach was also once dominated by Creekline Grassy Woodland. Vegetation in this reach is now dominated by exotic pasture grasses.

Native species diversity is limited in this reach and stock currently graze the riparian zone. Very occasional patches of remnant indigenous grasses and shrubs are found beneath scattered, over-mature Red Gums (*E. camaldulensis*). Native species are not regenerating.

In this area, large trees are scattered, canopy cover is reduced, very little understorey is present. Exotic species are in abundance while logs, recruitment and organic litter are virtually absent.

5.7.3. Habitat Quality

Habitat Quality assessments were undertaken where sections of the stream were representative of stream condition. Upon delineation of stream reaches for management purposes, some reaches did not have an assessment undertaken within them.

A habitat quality assessment was not undertaken in Reach 7. Habitat quality is expected to be low within this reach.

5.7.4. Threats and Risks

Threat	Risk
Re-incision of the main channel upstream toward the drop structure	Low
Widening of the incised channel directly downstream of the road crossing structure(currently numerous little headcuts on the gully sidewalls)	Moderate
Sediment starvation causing re-incision and widening of the channel	Moderate

Management Actions and Cost estimates for Reach 7are detailed in section 11. Works locations are shown in Appendix E.

6 Works Program and Cost Estimate for Implementation of Management Actions

Action Number	Management Action	Location		Provisional Quantity.	Unit	Rate ($)	Provisional Total* ($)	Notes	Priority
		Easting	Northing						
	Reach 1								
1.1	Address minor headcuts	692158	5 893243	2			$2,000	General location only	High
1.2	Fence off the main channel to control stock and stabilise active erosion sites	Start: 691520 End: 692 342	Start:5 893 181 End: 5 893 100	2700	metres	$6.00	$16,200		Medium
1.3	Undertake a thorough vegetation survey during Spring / Summer, prior to the start of any works			1		$500.00	$500		Medium

Action Number	Management Action	Location		Provisional Quantity.	Unit	Rate ($)	Provisional Total* ($)	Notes	Priority
		Easting	Northing						
1.4	Control rabbits on the slopes, particularly in the tributaries.	Cost borne under other programs							Medium
1.5	Increase soil recharge through steep hill planting,	Cost borne under other programs							Medium
	Reach 2								
2.1	Undertake longitudinal and cross section survey of left bank tributary to determine location for grade control structures	Survey included as part of entire Glendhu Creek survey (see Action CW1 and CW2 at the end of this Table)							High
2.2	Design and install grade control structures on left bank tributary	Start: 691 275 End:692 202	Start: 5 893 123 End:5 893 407	To be determined following survey			$50,000		High

Action Number	Management Action	Location		Provisional Quantity.	Unit	Rate ($)	Provisional Total* ($)	Notes	Priority
		Easting	Northing						
2.3	Fence and revegetate left bank tributary	Start: 691 275 End:692 202	Start: 5 893 123 End:5 893 407	4,900	metres	$6.00	$29,400		Medium
2.4	Control head cut	690 634	5 893 173	1		$2000.00	$2,000		Medium
2.5	Fence remnant vegetation to exclude stock to encourage natural regeneration and protect rare species.			3740	meters	$6.00	$22,440		Medium

Action Number	Management Action	Location		Provisional Quantity.	Unit	Rate ($)	Provisional Total* ($)	Notes	Priority
		Easting	Northing						
2.7	Undertake longitudinal and cross section survey to determine location for grade control structures	Start: 692 342 End:690 112	Start: 5 893 100 End:5 892 820	Refer action CW1 & CW2					High
2.8	Design and install grade control structures	Start: 692 342 End:690 112	Start: 5 893 100 End:5 892 820	10	each	$10,000	$100,000		High
2.9	Weed control, including targeted attack on Horehound and spot spraying of Spiny Rush	Cost borne under other programs							Medium

Action Number	Management Action	Location		Provisional Quantity.	Unit	Rate ($)	Provisional Total* ($)	Notes	Priority
		Easting	Northing						
2.10	Undertake a vegetation survey during Spring / Summer, prior to the start of any works			1	each	$500.00	$500		Medium
2.11	Control, rabbits, before any fencing, structural or revegetation works begin.	Cost borne under other programs							Medium
2.12	Increase soil recharge through steep hills planting	Cost borne under other programs							Medium
	Reach 3								
3.1	Fence and revegetate main channel to control stock and stabilise active erosion sites	Start:687 902 End:691 524	Start:5 891 495 End:5 893 186	8600	metres	$6.00	$51,600		Medium

Action Number	Management Action	Location		Provisional Quantity.	Unit	Rate ($)	Provisional Total* ($)	Notes	Priority
		Easting	Northing						
3.2	Undertake a vegetation survey during Spring / Summer to identify and map remnant native vegetation, including rare / endangered plant species			1	each	$500.00			Medium
3.3	Undertake survey of left bank tributary	Start:689 087 End: 691 058	Start:5 891 121 End: 5 890 616	1	each	$2000.00	$2,000		High
3.4	Place grade control structures* in tributaries to limit the amount of sediment entering the channel	Start:689 087 End: 691 058	Start:5 891 121 End: 5 890 616	To be determined following survey			$80,000		High

Action Number	Management Action	Location		Provisional Quantity.	Unit	Rate ($)	Provisional Total* ($)	Notes	Priority
		Easting	Northing						
3.5	Fence and revegetate tributary channel to protect structures.	Start:689 087 End: 691 058	Start:5 891 121 End: 5 890 616	4600	metres	$6.00	$27,600		High
3.6	Undertake longitudinal and cross section survey to determine location for grade control structures	Start: 692 202 End: 690 111	Start: 5 893 407 End: 5 892 817	Refer CW1 And CW2 at the end of this Table					High
3.7	Design and install grade control structures (main channel)	Start: 691 524 End: 688 081	Start: 5 893 186 End: 5 891 286	10	each	$10,000	$100,000		High
3.8	Control rabbits, before any fencing, structural or revegetation works begin.	Cost borne under other programs							High

Action Number	Management Action	Location		Provisional Quantity.	Unit	Rate ($)	Provisional Total* ($)	Notes	Priority
		Easting	Northing						
	Reach 4								
4.1	Fence main channel to control stock.	Start: 686 577 End: 691 524	Start:5 892 014 End: 5 893 186	3400	metres	$4.50	$15,300		High
4.2	Revegetation works within the main channel to trap and hold sediment.	Start: 686 577 End: 691 524	Start:5 892 014 End: 5 893 186	3400	metres	$1.50	$5,100		High
4.3	Control head cut within right bank tributary	687 316	5 892 240	1	each	$20,000	$20,000	Includes fencing	Medium
4.4	Undertake longitudinal and cross section survey to determine location for grade control structures	Start: 691 524 End: 688 081	Start: 5 893 186 End: 5 891 286	Refer CW! And CW2 at the end of this Table					High

Action Number	Management Action	Location		Provisional Quantity.	Unit	Rate ($)	Provisional Total* ($)	Notes	Priority
		Easting	Northing						
4.5	Design and install grade control structures	Start: 691 524 End: 688 081	Start: 5 893 186 End: 5 891 286	5	each	$10,000	$50,000		High
4.6	Control rabbits, before any fencing, structural or revegetation works begin.	Cost borne by other programs							High
	Reach 5								
5.1	Stop all gravel extraction in order to aid stream recovery.	685 045	5 892 738						High
5.2	Undertake vegetation survey in Spring / Summer								Medium

Action Number	Management Action	Location		Provisional Quantity.	Unit	Rate ($)	Provisional Total* ($)	Notes	Priority
		Easting	Northing						
5.3	Increase the soil recharge through steep hill planting	Cost borne under other programs							Medium
5.4	Control rabbits before any fencing, structural or revegetation works begin.	Cost borne by other programs							High
5.5	Undertake weed control, including targeted attack on Phalaris, Scotch Thistle, Spiny Rush and *Briar* Rose.	Cost borne by other programs							Medium
5.6	Rock beaching to protect eroding bank to prevent neck cut-off.	685 628	5 892 517	30	metres	$70.00	$2,100		High

Action Number	Management Action	Location		Provisional Quantity.	Unit	Rate ($)	Provisional Total* ($)	Notes	Priority
		Easting	Northing						
5.7	Rock beaching to Protect eroding bank	684 730	5 892 851	40	metres	$70.00	$2,800		High
5.8	Rock beaching to Protect eroding bank	684 467	5 892 814	25	metres	$70.00	$1,750		High
5.9	Rock beaching to Protect eroding bank	683 976	5 892 875	30	metres	$70.00	$2,100		High
5.10	Remove willow	683 793	5 892 913	1			$100		Medium
5.11	Rock beaching to Protect eroding bank	683 617	5 892 934	30	metres	$70.00	$2,100		High
5.12	Alignment training to protect redgum	683 458	5 892 877	1			$12,000		Medium
5.13	Rock beaching to Protect eroding bank	683 458	5 892 877	15	metres	$70.00	$1,050		High
5.14	Rock beaching to Protect eroding bank	683 361	5 892 879	25	metres	$70.00	$1,750		High

Action Number	Management Action	Location		Provisional Quantity.	Unit	Rate ($)	Provisional Total* ($)	Notes	Priority
		Easting	Northing						
5.15	Alignment training left and right bank	683 361	5 892 773	1			$15,000		High
5.16	Rock beaching to Protect eroding left and right banks	683 069	5 892 772	40	metres	$70.00	$2,800		High
5.17	Install grade control structure in road reserve, immediately downstream of bridge	682 748	5 892 800	1			$20,000		High
5.18	Undertake longitudinal and cross section survey of main channel	Survey included as part of entire Glendhu Creek survey							High
5.19	Design and construct grade control structures in main channel	Start:682 317 End: 686 572	Start:5 892 647 End: 5 892 006	10	each	$15,000.00	$150,000		High

Action Number	Management Action	Location		Provisional Quantity.	Unit	Rate ($)	Provisional Total* ($)	Notes	Priority
		Easting	Northing						
5.20	Fence and revegetate main channel			7950	metres	$6.00	$47,700		High
	Reach 6								
6.1	Fence remnant vegetation	684 531	5 890 697	75	metres	$6.00	$750		medium
6.2	Fix minor headcut	684 686	5 890 650	Informal rock work			$300		Low
	Reach 7								
7.1	Fence and revegetate tributary.	Start:683 840 End:684 113	Start:5 891 508 End:5 891 528	450	metres	$6.00	$2,700		Medium
7.2	Control weeds where appropriate	Cost borne by other programs							Medium
7.3	Monitor reach for new bed and bank erosion								Medium

Action Number	Management Action	Location		Provisional Quantity.	Unit	Rate ($)	Provisional Total* ($)	Notes	Priority
		Easting	Northing						
7.4	Control rabbits, before any fencing, structural or revegetation works begin.	Cost borne by other programs							Medium
	Catchment Wide Action								
CW1	Longitudinal & cross section survey from the Wimmera River confluence to the upper catchment						$14,000		High
CW2	Sediment transport & streampower modelling						$7000		High

Action Number	Management Action	Location		Provisional Quantity.	Unit	Rate ($)	Provisional Total* ($)	Notes	Priority
		Easting	Northing						
						Total Works Program Cost	**$860,200***		

* Total Cost has not considered cost sharing

Wimmera CMA offers landholders incentive rates to undertake fencing and revegetation of streamside areas. Details of this scheme are outlined in the following table:

7 Wimmera CMA 04/05 Incentive Rates

The rates shown in the Table on the following page represent the full incentives that will be paid. They have been calculated to consider the full cost of the works. For example, the price of $1.00 for a plant, includes plant establishment costs such as weed control, deep ripping and tree guards, as well as the purchase of the plant. As these costs have been considered in the incentive rates, additional funding is not available for these activities.

Activity	Priority	WCMA cost share	Criteria		Incentive	Unit
Waterways Fencing	VH	90%	Frontage >20m & Very High, High or medium conservation significance		Contact Glenn Dixon, WCMA, regarding waterway works prior to inspecting proposed projects. 5382 1544	
	H	80%	Frontage >20m, low conservation significance			
	M	60%	Frontage 10 - 20m			
	L	40%	Frontage <10m			
Off stream watering	VH	50%	Solar pump. 50% of total project cost. Maximum grant $3000			
	H	50%	Dam. 50%of construction cost. Maximum grant $1000			
Remnant Vegetation Fencing	VH	100%	Very high, high or medium conservation significance, with Trust for Nature Conservation covenant in place		$ 3.55	m
	H	75%	High to Very High Conservation significance		$ 2.65	m
	M	65%	Medium to Low conservation significance		$ 2.30	m
Land class fencing	M	60%	Fencing land class 4 & 5		$ 2.15	m
Revegetation fencing	VH	80%	Very High Conservation significance potential	PMP*	$ 2.85	m
		70%		No PMP	$ 2.50	m
	H	70%	High Conservation significance potential	PMP	$ 2.50	m
		60%		No PMP	$ 2.15	m
	M	55%	Medium Conservation significance potential	PMP	$ 1.95	m
		45%		No PMP	$ 1.60	m
	L	35%	Low Conservation significance potential	PMP	$ 1.25	m
		25%		No PMP	$ 0.90	m
Revegetation	H	80%	Plants: 80% of cost of plants, guards and follow up weed control for 12 months.		$ 1.00	each
	H	80%	Direct Seeding: 80% of cost of seed and follow up weed control for 12 months.		$ 160	km
Erosion control works	VH	80%	Works are part of an existing Property Management Plan / whole farm plan		Up to 80% of cost of Priority works	
	H	60%	No Property Management Plan / Whole Farm Plan completed		Up to 60% of cost of Priority works	
Saline Pasture	M	20%			$48	Ha
Saltbush	M	65%	Costing includes cost of plants and mounding.		$0.25	each
Fencing to protect salinity management works#	VH	80%	Works in “Implementation” priority GFS	PMP	$ 2.85	m
		70%		No PMP	$ 2.50	m
	H	70%	Works in “Research and development” priority GFS	PMP	$ 2.50	m
		60%		No PMP	$ 2.15	m
	M	55%	Works in “Co-investment” priority GFS	PMP	$ 1.95	m
		45%		No PMP	$ 1.60	m
	L	35%	Discharge Fencing	PMP	$ 1.25	m
		25%		No PMP	$ 0.90	m

* To be eligible for higher rates, inspecting officer must sight completed Property Management Plan or Whole Farm Plan

Higher incentive rates may be available for salinity works if they have conservation outcomes. In such cases rates for revegetation may be applied.

8 References

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