

Appendix D: Processes and results for validating investment priorities

D.1 Validation of risks

Secondary salinity

The Salinity Action Plan (SAP) Background Report No 2 'Process for the initial selection and validation of target areas for salinity management' outlines the method used to define priority areas and the assessment process used to validate the risk from secondary salinity (Dahlhaus 2003). The results from this report in addition to the other SAP background reports have been used to verify the high risk to assets from secondary salinity in those landscape zones identified as a priority in the Corangamite SHS. Since both the SAP and SHS have adopted an assets-based approach to targeting investment, the high risk to assets caused by secondary salinity in the Lismore, Stony Rises, Woody Yaloak and Murdeduke landscape zones is ratified by the degree of overlap between the SAP target areas and the landscape zones where secondary salinity is a priority issue in this strategy (Fig. D1).

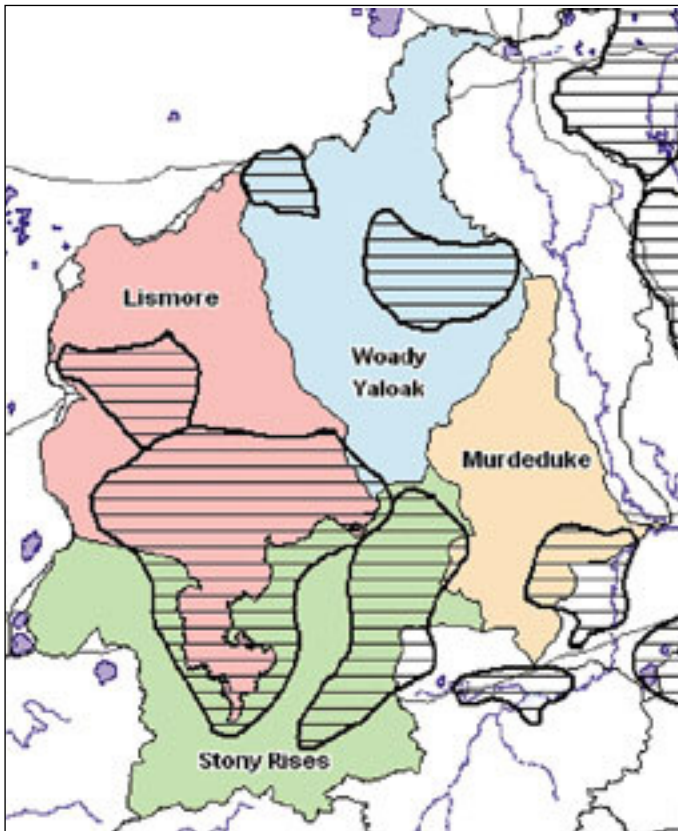


Figure D1: The overlap between the Corangamite Salinity Action Plan target areas (hatched) and the four landscape zones where secondary salinity is a priority in the Corangamite Soil Health Strategy

Lismore Landscape Zone

The Lismore Landscape Zone overlaps with the Lismore-Derrinallum and Lake Corangamite salinity management target areas of the SAP. The asset-threat investigations in the SAP confirmed that secondary salinity posed a possible risk to roads, rail, waterways, telecommunication cables, agricultural land, reservoirs, VROTS and Lake Corangamite in the Lismore Landscape Zone (Dahlhaus 2003).

Stony Rises Landscape Zone

The Colac-Eurack and Lake Corangamite SAP target areas overlap with the Stony Rises Landscape Zone where it has been recognised that secondary salinity threatens the integrity of roads, rail, electricity cables, waterways, telecommunication cables, agricultural production, VROTS, Ramsar wetlands and the urban development in the City of Colac (Dahlhaus 2003).

Illabarook Landscape Zone

The Pittong and Illabarook SAP target areas in the Woody Yaloak Landscape Zone were selected on the basis of the increasing salinity in the Woody Yaloak River and Lake Corangamite. It is also recognised that the area of agricultural land affected by salinity is increasing by 8% per annum in the Pittong area, where roads are also affected (Nicholson *et al.* 2006).

Murdeduke Landscape Zone

Approximately half of the Murdeduke SAP target area overlaps with the Murdeduke Landscape Zone, along with a small portion of the Colac-Eurack SAP target area. The SAP recognises that secondary salinity in these regions threatens the integrity of roads, electricity cables, telecommunication cables, agricultural production, VROTS and wetlands (Nicholson *et al.* 2006).

Landslides

The methodology for verification of risk associated with landslides throughout the Corangamite region focused on the confirmation of landslides at mapped locations, an assessment of the likelihood of further movement and the potential for impact on various assets classes including infrastructure, water quality, biodiversity (environment) and land use. A series of target areas based on a GIS analysis were proposed for each priority landscape zone and field inspections and risk assessments were undertaken in the Gellibrand, Curdies, Otway Coast, Upper Barwon and Aire landscape zones.

Gellibrand Landscape Zone

The highest-ranking landscape zone was the Gellibrand, which was found to contain a diverse range of landslides (*Table D1*). Significant impacts were noted on major tourist roads at various locations on the Great Ocean Road, including a recent failure at Princetown requiring engineering works and major stabilisation. In excess of \$700,000 for remediation works were required on Turtons Track due to landslide damage after a severe rainfall event in February 2004 and ongoing occurrences of landslides below these remedial works were noted during the recent inspection (*Fig. D2*).

Other roads such as Kawarren Road and Colac – Lavers Hill Road have also been damaged or impacted through the occurrence of landslides. Ongoing landslide movement on the Princetown-Simpson Road on the western boundary of this zone has caused extensive road damage as well as the destruction of a number of sheds and the severe damage and ultimate demolition of a dwelling. The potential for damage to dwellings was also noted at Johanna, where a number of cabins are located on a large, active landslide.

Significant risk to water supply infrastructure and water quality was also confirmed at West Gellibrand Reservoir where an old landslide has reactivated in recent times on one of the flanks of the water supply reservoir. In addition, a landslide adjacent to Arkins Creek is known to have impacted on water quality whilst also threatening the main water supply to Camperdown. Other minor risks to water quality were also identified in the Johanna area and along the Gellibrand River, although impact was restricted due to limited travel distance or run-out.

Although inspection of forestry and logging operations was restricted by road access, such activity has been assessed as having potential to impact on water quality through initiation of landslides and erosion if good forestry practice is not adhered to. A major slide on the Aire River and subsequent plantation establishment resulted in some sections of this operation now being unusable due to the potential for further movements and impact on the river.

Finally, risks to agricultural land were identified in the Johanna area, the area east of Simpson at Tomahawk Creek and at Kennedy's Creek where shallow translational slides in the Gellibrand Marls have caused minor disruption to pastures and grazing lands.

Otway Coast Landscape Zone

The main impacts from landslides in the Otway Coast Landscape Zone were confirmed as damage to infrastructure and disruption to road infrastructure affecting tourism (*Table D1*).

Significant numbers of dwellings have been located within or adjacent to two large coastal landslides at Fairhaven. Whilst impact to date has been minimal, potential risks exist if larger movements associated with reactivation under adverse conditions occur. Other locations within this zone have also been assessed as having moderate to high risks of property damage associated with the occurrence of landslides and

include some isolated parts of Lorne, Wye River, the northern areas of Skenes Creek, Wongarra, some outer areas of Apollo Bay and rural developments in the adjacent valleys of Barham River and Wild Dog Creek.

A significant and ongoing impact from landslides has occurred on the Great Ocean Road and recent closures of this major tourist road have occurred at Big Hill outside Lorne and at Cumberland River. A large-scale failure occurred on the Great Ocean Road in the late 1970s at Windy Point to the west of Lorne. This slide closed the Great Ocean Road for six months and required significant engineering stabilisation works using numerous rock bolts. Such installations have a limited design life and further works can be expected in the future; newly installed monitoring instrumentation at the site by VicRoads confirms the ongoing risks associated at this site. Numerous slides also occur regularly along stretches of the Great Ocean Road near Jamieson River and Kennett River. Inspections of these sites indicate ongoing potential for minor failures requiring maintenance and clean-ups.

Curdies Landscape Zone

The main impacts within the Curdies Landscape Zone occur on major road infrastructure, sites of natural beauty and agricultural lands (*Table D1*).

Significant and ongoing damage has been experienced along the Port Campbell – Cobden Road, which is a major tourist route to the Twelve Apostles and other sites of natural importance. Remedial works have failed to fully alleviate damage associated with shallow translational slides (so typical of the region) which transect the road in a number of locations. Damage to a series of timber retaining walls along minor roads (such as Williams Road), and the Timboon – Colac Road has also been identified as being caused by relatively shallow but long translational landslides. Significant damage has continued to occur on the Princetown – Simpson Road, which is located on the boundary with the Gellibrand Landscape Zone.

Significant disruption to agricultural land has occurred throughout the region due to numerous and widespread shallow translational landslides. Whilst the impact has been minor in many cases, some areas have been completely removed from usage and have been fenced off and, in some cases, actively remediated.

Ongoing landslides and instability along the coast have also recently impacted on the natural environment and include the collapse of one of the Twelve Apostles and London Bridge. Impact on waterways and wetlands is considered to be relatively minor, although many small failures are noted directly adjacent to creeks and streams with some potential for sediment loading.

Upper Barwon Landscape Zone

The Upper Barwon Landscape Zone is characterised by potential impacts to water quality, including Proclaimed Water Supply Areas, with some risks to agricultural lands (Table D1).

Minor slides on the Barwon River on the Lorne-Winchelsea Road were noted as having a minor risk to water quality, with a similar assessment of risks along some of the smaller creeks such as Scrubby Creek. More significant risks have been assessed for some sections of the water supply infrastructure in the region, with landslides known to have impacted on the main supply channel and associated syphons taking water from the West Barwon Dam to the Wurdee Boluc Reservoir. Other isolated slides are also known to have occurred adjacent to the channel near Wurdale Road. Any long-term disruption to this channel represents a significant risk to Geelong's water supply network.

The potential impact of rarer, large-scale landslides in this area was graphically illustrated in 1952 when the Lake Elizabeth landslide failed and blocked the east branch of the Barwon River. The slide was in the order of 60 hectares and significantly disrupted flows in the river until the landslide dam was breached in the following year, sending a 7 m wall of mud and water down the river.

Disruption and loss of agricultural lands was also noted along a long section of the Barwon River at Birregurra. Assessment of the Phillips Landslide indicated approximately four hectares had been lost as viable grazing land; there was also the potential that further reactivation may have an impact on the Barwon River (Fig. D4).

Aire Landscape Zone

The Aire is the smallest of the landscape zones within the Corangamite region and contains limited infrastructure but includes areas of significant environmental importance such as the Great Otway National Park (Table D1). As such, the risks are mainly associated with water quality and the environment.

Some minor infrastructure risks are present along the Great Ocean Road. A number of landslides directly adjacent to the road were noted during the recent inspection and will require remedial engineering works. Other recent engineering repair works due to landslides have also been undertaken by Colac Otway Shire on Wait-a-While Road. Landslides are also known to have caused some damage on the Hordern Vale Road.

Risks to water quality and the environment were recently emphasised by the closure of the Ford River due to a landslide, which occurred after forestry activities. Other areas of logging and forestry were also noted at the northern end of Bins Road and in the Beech Forest area and whilst access to such areas was restricted, risk to water quality and the environment are considered possible if good forestry practice is not employed (Fig. D3).

Water erosion

The verification of risk associated with water erosion used the same method as for landslides. A series of target areas based on a GIS analysis were proposed for each priority landscape zone; field inspections and risk assessments were undertaken in the Woody Yaloak, Moorabool, Thompsons, Upper Barwon and Leigh landscape zones.

Field verification showed that sheet/rill erosion and gully/tunnel erosion were found together and there were no clear spatial boundaries that could distinguish where gully/tunnel and sheet/rill started and finished. Therefore, it was decided that sheet/rill erosion and gully/tunnel erosion should be assessed together and they would be ranked together for each priority landscape zone.

Woody Yaloak Landscape Zone

Along with the Moorabool, erosion by water in the Woody Yaloak Landscape Zone was verified to have the highest risk of all landscape zones (Table D2). The most severe erosion in the Woody Yaloak, and perhaps the Corangamite region, was on the hills surrounding the Misery and Moonlight creeks (Fig. D5). This area had extensive sheet, rill and gully erosion. Significant sedimentation to the Misery and Moonlight creeks from the erosion is highly likely. Much of this sediment will flow into the Woody Yaloak River, which will eventually flow into Lake Corangamite.

| Priority Landscape Zones | Land use | Water Quality | Bio-diversity | Infrastructure | Verification of risk score | Revised rank according to verification |
|--------------------------|----------|---------------|---------------|----------------|----------------------------|--|
| Gellibrand | 3.0 | 4.0 | 1 | 4.5 | 12.5 | 1 |
| Curdies | 3.5 | 2.0 | 1 | 4.0 | 10.5 | 3 |
| Otway Coast | 2.0 | 2.0 | 3 | 5.0 | 12.0 | 2 |
| Upper Barwon | 2.0 | 4.5 | 1 | 1.0 | 8.5 | 4 |
| Aire | 1.0 | 3.0 | 2 | 2.0 | 8.0 | 5 |

Table D1: Field verification scores for landslide risk in priority areas. Risk to assets is indicated as very high-5, high-4, medium-3, low/medium-2, low-1



Figure D2: New failure below recent remedial works on Turtons Track (Gellibrand Landscape Zone) Photograph: A. Miner 2006

The erosion has significantly impacted on agricultural production in the Misery and Moonlight area. Many of the hills have no livestock as there is no ground cover available for feed. Some farmers have spent thousands of dollars over the years to address the erosion and to bring back the productive value of their land. Amelioration of erosion in the area has had varying success.

There are also a number of erosion sites along the Rokewood-Ballarat Road, Paddy Gully Road and the area just north of Rokewood township. Some of these erosion sites are large, but relatively stable. Other sites are active and appear to be impacting on the water quality of nearby creeks that eventually flow into the Woody Yaloak River. Agricultural production is also degraded as a result of the erosion in these areas. A few gravel roads are possibly under threat from erosion.

Some remnant vegetation along the gullies may be at risk from the erosion. Erosion may occur around trees and shrubs, causing them to fall. The impact of erosion on native grasslands is relatively unknown.

Moorabool Landscape Zone

According to the field verification, the Moorabool Landscape Zone is equally at the highest risk from water erosion (*Table D2*). The severity of erosion in the Moorabool Landscape Zone is not quite as significant as the Woody Yaloak, but the consequences in the Moorabool are much higher, mostly because it is within a Proclaimed Water Supply Area.

Field verification found a number of active erosion sites along most of Eclipse Creek, which is a tributary of the Moorabool River north-east of Meredith (*Fig. D6*). This area has numerous sheet, rill and gully erosion sites, most of which were active.

Sedimentation from Eclipse Creek is likely to contribute sediment loads into the Moorabool River and eventually into water supply reservoirs and into the Barwon River, which flows into Lake Connewarre. Investigations have linked sediments found at Lake Connewarre to sediments derived from the Moorabool River. Central Highlands Water and Barwon Water have expended large resources in the past for water quality treatment and dredging sediments from their water supply reservoirs.

The Eclipse Creek area is used mostly for grazing purposes. Erosion in this area adversely impacts on pasture production used for agriculture.

The upper west branch of the Moorabool River also has significant and active erosion that causes sedimentation of the Moorabool River and adversely impacts on agricultural production. Erosion is obvious in farming areas bordering the Brisbane Ranges National Park. Some erosion is found within the actual national park, which potentially threatens remnant vegetation. Some smaller gravel roads also appeared to be under threat from erosion, particularly around the Brisbane Ranges.



Figure D3: Forestry and logging with minor landslides and erosion on waterway just off the Great Ocean Road (Aire Landscape Zone) Photograph: A. Miner 2006



Figure D4: Landslides adjacent to Scrubby Creek (Upper Barwon Landscape Zone) Photograph: A. Miner 2006

Leigh Landscape Zone

The Leigh Landscape Zone was verified to be the third-highest area at risk from water erosion, after the Moorabool and Woody Yaloak Landscape Zones (Table D2). Severe erosion sites are located along Sand Road between Grenville and Garibaldi. Some of these sites are gullies up to eight metres deep, with tunnel erosion also occurring nearby (Fig. D7). High sediment loads are likely from these erosion sites into tributaries of the Leigh River. The Leigh River also enters the Barwon River, which flows into Lake Connewarre. It is likely that a significant volume of sediment at Lake Connewarre has come from the Leigh River.

Agricultural production is adversely impacted along Sand Road. However, there are a number of properties in this area that do not use the land for agriculture.

Gully erosion is found along the Bamganie Road, east of Mount Mercer. Some of these sites are active, while others have grassed over and are now stable. Sedimentation of waterways from the active sites is likely to impact Cargerie and Woodbourne creeks, which flow into the Leigh River.

Gully and tunnel erosion sites are found on Moss Avenue and Magpie Road, just north of Buninyong. Erosion has impacted the road along Moss Avenue, which has been ameliorated by the City of Ballarat. Deep tunnel erosion is occurring in a native forested area along Magpie Road. This site is up to five metres deep and is likely to be contributing significant sediment loads to the Leigh River. Remnant vegetation is also under threat, with much of the erosion area being taken over by gorse, a noxious woody weed that is widespread in this locality.

Upper Barwon Landscape Zone

The Upper Barwon was ranked fourth-highest landscape zone for erosion by water after verification (Table D2). The likelihood of erosion causing risk to water quality was relatively low, but the consequence of sedimentation is high as the area sits within a Proclaimed Water Supply Area.

Verification found that many of the erosion sites mapped along the Warncoort-Birregurra Road are streambank sites that have recently been fenced off and revegetated. As a result of these works, the erosion appears to be relatively stable.

Stream-bank erosion sites around Coal Mine Road have also recently been fenced off and revegetated. It appears these sites were once very active, but works appear to have stabilised much of the erosion.

A few smaller active erosion sites were found along the Barwon River and may contribute some sediment into the waterway.

Tunnel and gully erosion was verified to be impacting on Wormbete Station Road and the Deans Marsh Road, at Deans Marsh. These sites were 2-3 metres deep and were undercutting the road. VicRoads has stabilised the sites using stabilisation sand. These roads may still be under threat from tunnel erosion, with the risk from tunnelling more difficult to assess.

Small areas of agricultural production were threatened by erosion throughout sections of the Upper Barwon Landscape Zone, mostly on grazing land. Some riparian remnant vegetation may be at risk from streambank erosion.

Thompsons Landscape Zone

Field verification ranked the Thompsons Landscape Zone the lowest risk out of all erosion priority areas, as there was little evidence of erosion causing risk to high-value public assets (Table D2). Many of the sites assessed had stabilised and were showing little signs of impact.

According to the desktop analysis, 20 ha of high conservation area overlapped with a sheet/rill erosion site. Verification found that there was very little impact from the erosion on this conservation area.

| Priority Landscape Zones | Land use | Water Quality | Bio-diversity | Infrastructure | Verification of risk score | Revised rank according to verification |
|--------------------------|----------|---------------|---------------|----------------|----------------------------|--|
| Woody Yaloak | 4 | 4 | 3 | 2 | 13 | =1 |
| Moorabool | 3 | 5 | 3 | 2 | 13 | =1 |
| Thompsons | 1 | 2 | 2 | 1 | 6 | 5 |
| Upper Barwon | 2 | 3 | 2 | 1 | 8 | 4 |
| Leigh | 2 | 3 | 3 | 2 | 10 | 3 |

Table D2: Field verification scores for water erosion risk in priority areas. Risk to assets is indicated as very high-5, high-4, medium-3, low/medium-2, low-1



Figure D5: The pale areas indicate areas of sheet, rill and gully erosion in the Moonlight Creek area (Woody Yaloak Landscape Zone)



Figure D6: A gully erosion site along Eclipse Creek (Moorabool Landscape Zone)



Figure D7: A gully erosion site connecting with a tributary close to the entry of the Leigh River (Leigh Landscape Zone)

Acid sulphate soils

Bellarine Landscape Zone

Acid sulphate soils in the Bellarine Landscape Zone ranked highly according to the initial relative risk to assets analysis. An investigation was carried out by CSIRO in 2005 that assessed the potential risk of acid sulphate soils in the City of Greater Geelong, which includes the Bellarine Landscape Zone. Results from the CSIRO study indicated that despite 11,745 ha of potential acid sulphate soils found in the Bellarine region, most were located in areas that are unlikely to be disturbed and therefore pose no threat.

The conclusion from the CSIRO investigation was although potential acid sulphate soils are found throughout the City of Greater Geelong, they are mostly confined to public conservation and resource areas. An exception to this in the Bellarine Landscape Zone was the tidal flat adjacent to the smelting plant at Point Henry. The site at Point Henry was the only one tested which had any acid sulphate soil potential and this was considered marginal at most (CSIRO 2005).

As a result of the CSIRO study, it could not be verified that there is a high-potential risk from acid sulphate soils in the Bellarine Landscape Zone. Because of this, the initial high rank for acid sulphate soils in the Bellarine Landscape Zone could not stand and, accordingly, was re-ranked as a lower priority.

The overstating of the Relative Risk Value for acid sulphate soils in the Bellarine Landscape Zone was created by the large area of potential acid sulphate soils that overlap with wetlands. Potential acid sulphate soils are normally found in wetland environments, but when left undisturbed and saturated they pose no risk. Wetlands found in the Bellarine Landscape Zone normally lie in protected reserves that are unlikely to be disturbed and therefore the risk from acid sulphate soils in these areas is low.

Thompsons Landscape Zone

There was no information available to verify the potential risk of acid sulphate soils in the Thompsons Landscape Zone. From the CSIRO study carried out for the Bellarine area, it can be assumed that most of the potential acid sulphate soils in the Thompsons area are also located where disturbance is unlikely and risk is low. Because of this, acid sulphate soils in the Thompsons Landscape Zone remained as a low-ranked priority.

D.2 Impact on high value public assets

The true benefit of soil health management actions depends on the effectiveness of the action in reducing the risk of a threat to a specific asset. For example, on-ground works to reduce or stop active gully erosion in a Proclaimed Water Supply Area will have a greater benefit than on-ground works to reclaim an inactive gully outside of the water supply catchment. Similarly, in the relative risk assessment, the Relative Asset Value does not discriminate between the relative values of the same asset class. In other words, the Relative Asset Value for a wetland is 10, regardless of the fact some wetlands have international status, (those listed under the Ramsar Convention, or under migratory bird treaties) and others have only local status.