

APPENDIX I2

INVERBRACKIE CREEK EPA REPORTS

BIRD IN HAND GOLD PROJECT

MINING LEASE PROPOSAL MC 4473



ABN | 66 122 765 708

Unit 7 / 202-208 Glen Osmond Road | Fullarton SA 5063

Inverbrackie Creek, near Woodside 2008 Aquatic Ecosystem Condition Report

 epa.sa.gov.au/reports_water/c0032-ecosystem-2008

Condition overview

Key points:

Area map

About the location

Inverbrackie Creek rises to the north and east of Woodside in the southern Mount Lofty Ranges, and flows west into the Onkaparinga River, to the south of Woodside. Livestock grazing (44%), dairying (24%) and horticulture (18%) are the main land uses in this small catchment, as well as some vineyards, urban living, forests and areas of remnant native vegetation.

The site selected for monitoring was located in the lower reaches of the stream, off the Woodside–Nairne Road, over one kilometre south of Woodside, upstream from the bridge.

[Adelaide and Mount Lofty Ranges NRM Regional Summary 2008](#)



In summary

The creek was given a Very Poor rating at this site because the [ecosystem](#) showed evidence of major changes to both the animal and plant life, and a significant breakdown in the way the ecosystem functions because of human impact. The stream had been severely affected by nutrient enrichment, and the riparian zone was significantly disrupted, with limited native vegetation.

[Close](#)

Findings

A series of shallow, connected pools formed the creek at the time of inspection in spring 2008.

A sparse community of 18 [macroinvertebrate](#) species was collected. The community was dominated by moderate to large numbers of organic-feeding species such as tiny [crustaceans](#) called water scuds (*Austrochiltonia australis*), freshwater isopods (*Heterias pusilla*) and chironomids (*Corynoneura* and *Paralimnophyes*). The absence of insects such as mayflies, stoneflies, caddisflies and dragonflies highlighted the poor condition of the stream.

The water was moderately fresh (salinity of 1,600 mg/L), moderately well oxygenated (42% saturation) and clear. It contained high levels of nutrients such as nitrogen (0.8 mg/L) and phosphorus (0.11 mg/L).

The [sediments](#) were mostly [detritus](#) and silt; they were blackened and strongly [anaerobic](#) when disturbed, indicating too much organic matter was entering the creek.

The water was covered with aquatic plants such as the fern Pacific Azolla (*Azolla filiculoides*) and duckweed (*Spirodela*); large amounts of introduced Watercress (*Rorippa nasturtium-aquaticum*) grew along the edges.

The streambanks had been heavily eroded by livestock accessing the stream, and from occasional flooding.

Small patches of River Red Gums and exotic willow trees grew in the [riparian zone](#), which had also been invaded by introduced grasses and woody weeds such as blackberries and gorse.

Cereal cropping and grazing occurred over the surrounding area, and there was little or no native vegetation remaining, apart from along the roadsides.

[Close](#)

Special environmental features

None identified.

[Close](#)

Pressures and management responses

Pressures	Management responses
Livestock have direct access at the site and upstream, causing sediment erosion and adding excessive nutrients (which leads to habitat disturbance, algal growth and aquatic weeds).	The Adelaide and Mount Lofty Ranges NRM Board's land management program encourages and promotes managing land to improve water quality. This includes incentives for waterway and wetland fencing to exclude or limit stock from entering riparian zones.
Limited riparian zone vegetation at the site and upstream, providing minimal buffer protection from catchment landuses (reducing habitat quality).	The Adelaide and Mount Lofty Ranges NRM Board's land management program encourages and promotes managing land to improve water quality. This includes incentives for revegetation programs around waterways and wetlands and stock exclusion as well as educating landholders about the importance of riparian vegetation in managing soil erosion.
Large decrease in natural water flows (reducing ecological integrity).	Through water allocation planning the Adelaide and Mount Lofty Ranges NRM Board seeks to manage a sustainable water supply for the region so that there is enough water available for everyone (including the environment) even in drought conditions.
Extensive weed growth in the riparian zone at the site and upstream (reducing habitat quality).	The Adelaide and Mount Lofty Ranges NRM Board has several pest plant (weed) mitigation and control programs. They work closely with landholders to control weeds on their property and to help stop the spread to other properties and waterways.
Large nutrient inputs from numerous diffuse sources in the catchment (leading to extensive growth of algae and aquatic weeds)	The Adelaide and Mount Lofty Ranges NRM Board's land management program encourages and promotes managing land to improve water quality. This includes working with industry and landholders to ensure efficient use of fertilisers and discuss ways to reduce runoff of nutrients into waterways.

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Further information

Gallery

This aquatic ecosystem condition report is based on monitoring data collected by the EPA and prepared in conjunction with the [Adelaide and Mount Lofty Ranges NRM Board](#).

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Last modified: 24/04/2015



Government of South Australia

Adelaide and Mount Lofty Ranges
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Inverbrackie Creek, near Woodside 2011 Aquatic Ecosystem Condition Report

 epa.sa.gov.au/reports_water/c0032-ecosystem-2011

Condition overview

Key points:

- Permanently wet, moderately fresh, slow-flowing creek in autumn and spring 2011
- Moderately diverse [macroinvertebrate](#) community with a few rare and sensitive species
- Obvious signs of moderate to gross [nutrient enrichment](#)
- [Riparian](#) vegetation dominated by woody weeds and introduced grasses



Area map

About the location

Inverbrackie Creek rises to the north and east of Woodside in the southern Mount Lofty Ranges, and flows west into the Onkaparinga River, to the south of Woodside. Livestock grazing (44%), dairying (24%) and horticulture (18%) are the main land uses in this small catchment, as well as some vineyards, urban living, forests and areas of remnant native vegetation.

The site selected for monitoring was located in the lower reaches of the stream, off the Woodside–Nairne Road, over one kilometre south of Woodside, upstream from the bridge.

[Adelaide and Mount Lofty Ranges NRM Regional Summary 2011](#)

In summary

The creek was given a Poor rating because the site sampled showed evidence of major changes in ecosystem structure, and moderate changes to the way the ecosystem functions. There was considerable evidence of human disturbance including nutrient enrichment, degraded riparian vegetation and fine sediment deposition in the creek.

[Close](#)

Findings

A moderately diverse community of at least 36 species of macroinvertebrates was collected from the slow-flowing creek, 2.2-2.6 m wide and up to 32 cm deep, in autumn and spring 2011. The creek consisted of still to slightly trickling pools in autumn but also included small areas of fast-flowing riffle habitats in spring. The community was dominated by generalists and species tolerant to poor water quality such as worms, amphipods (*Austrochiltonia*), chironomids and waterbugs (*Micronecta*). It also included smaller numbers of flatworms, nematodes, limpets, native and introduced snails, isopods, freshwater shrimp, yabbies, springtails, beetles, biting midges, mayflies, waterbugs, odonates, stoneflies and caddisflies. A few rare and sensitive species were collected in very low numbers, including a stonefly (*Dinotoperla evansi*) and two mayflies (*Atalophlebia australis* and *Thraulophlebia inconspicua*). The site also supported a small number of species normally associated with flowing habitats,

including a dytiscid beetle (*Platynectes decempunctatus*), chironomid (*Rheotanytarsus*) and the above-listed rare and sensitive species. The only fish seen at the site was an introduced pest species called Mosquitofish (*Gambusia*).

The water was fresh to moderately fresh (salinity ranged from 916-1,054 mg/L), well oxygenated (89-93% saturated), clear, and with moderate to high concentrations of nutrients such as nitrogen (0.51-0.88 mg/L) and phosphorus (0.04-0.05 mg/L).

The sediments were dominated by detritus, boulder, algae, silt and sand. Samples taken from below the surface were slightly blackened, anaerobic and sulfidic, indicating that the sediments lacked oxygen. A large deposit of fine silt, 1-5 cm deep, covered the streambed in places and over 10 m of bank showed evidence of erosion caused by cattle damage.

Over 10% of the creek was covered by filamentous algae (*Cladophora* and *Spirogyra*) and aquatic plants occasionally covered more than 35% of the site. Extensive growths of a floating fern (*Azolla*) and introduced watercress (*Rorippa*) were recorded but the site also supported patches of submerged (*Callitriche*) and emergent species (*Cotula*, *Juncus*, *Phragmites*, *Rumex* and *Crassula*). The riparian vegetation was dominated by woody weeds (gorse, blackberries and broom) and introduced grasses. The surrounding vegetation was cleared grazing land with a few isolated gum trees in the local landscape.

[Close](#)

Special environmental features

Inverbrackie Creek provides permanent, freshwater habitats that support a few rare and sensitive flow-dependent macroinvertebrate species.

[Close](#)

Pressures and management responses

Pressures	Management responses
Insufficient natural water flows in the creek resulting from water extraction and climate variability (reducing ecological integrity).	Through water allocation planning the Adelaide and Mount Lofty Ranges NRM Board seeks to manage a sustainable water supply for the region so that there is enough water available for everyone (including the environment) even in drought conditions.
Widespread introduced weeds in the riparian zone at the site and upstream (reducing habitat quality).	The Adelaide and Mount Lofty Ranges NRM Board has several pest plant (weed) mitigation and control programs. They work closely with landholders to control weeds on their property and to help stop the spread to other properties and waterways.
Livestock having direct access at the site and upstream (causing sediment erosion and adding excessive nutrients).	The Adelaide and Mount Lofty Ranges NRM Board's land management program encourages and promotes managing land to improve water quality. This includes incentives for waterway and wetland fencing to exclude or limit stock from entering riparian zones.
Limited riparian zone vegetation at the creek and upstream (reducing habitat quality, increasing sediment erosion).	The Adelaide and Mount Lofty Ranges NRM Board's land management program encourages and promotes managing land to improve water quality. This includes incentives for revegetation programs around waterways and wetlands and stock exclusion as well as educating landholders about the importance of riparian vegetation in managing soil erosion.

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Further information

Gallery

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Inverbrackie Creek, near Woodside 2013 Aquatic Ecosystem Condition Report

 epa.sa.gov.au/reports_water/c0032-ecosystem-2013

Condition overview

Key points:

- Permanent to near permanently flowing stream in autumn and spring 2013
- Moderately diverse [macroinvertebrate](#) community dominated by organic feeders and lacking any rare or sensitive species
- Water was moderately fresh, slightly coloured and [enriched with nutrients](#)
- [Riparian](#) vegetation consisted of weedy shrubs over introduced grasses and weeds



Area map

About the location

Inverbrackie Creek is a moderately sized stream that rises to the north and east of Woodside in the southern Mount Lofty Ranges, and flows west into the Onkaparinga River, to the south of Woodside. Grazing modified pastures (53%) was the main land use in the 2,589 hectare catchment upstream from the site sampled, with smaller areas used for irrigated pastures and horticulture, cropping, roads, residential housing, plantation forestry, dams, irrigated cropping and native vegetation. The site selected for monitoring was located in the lower reaches of the stream, off the Woodside–Nairne Road, over one kilometre south of Woodside, upstream from the bridge.

[Adelaide and Mount Lofty Ranges NRM Regional Summary 2013](#)

In summary

The creek was given a Poor rating because the site sampled showed evidence of major changes in [ecosystem](#) structure and moderate changes to the way the ecosystem functions. There was clear evidence of human disturbance at the site due to nutrient enrichment, the mobilisation of fine sediment and the extent of weeds in the riparian zone.

[Close](#)

Findings

A moderately diverse community of at least 29 species of macroinvertebrates was collected or seen from the creek (17 species in autumn and 22 in spring), 1-8-3.4 m wide and up to 42 cm deep, in autumn and spring 2013. The creek consisted of mostly still to slow-flowing pool habitats connected by tiny areas of faster-flowing, shallower riffle habitats in both seasons sampled. The community was dominated by moderate numbers of amphipods (*Austrochiltonia australis*), native (*Glyptophysa concinna*) and introduced snails (*Potamopyrgus antipodarum* and *Physa acuta*), and springtails (Family Hypogastruridae). It also included smaller numbers of turbellarians, worms, shrimp, yabbies, beetles, biting midges, chironomids, mosquitoes, waterbugs, damselflies and caddisflies. The riffles also supported blackfly larvae (probably *Simulium ornatipes*) that were seen clinging to rocks in spring. All macroinvertebrates collected were tolerant and generalist species that are well adapted to

tolerate and thrive in organically polluted streams, and each has a wide distribution throughout the agricultural area of South Australia. No rare or sensitive species were recorded and the blackfly was the only flow-dependent species seen at the site. The only fish seen at the site was a threatened species called Mountain Galaxias (*Galaxias olidus*) in spring.

The water was moderately fresh (salinity ranged from 1,233-1,463 mg/L), well oxygenated (76-152% saturation), clear but slightly coloured, and with generally high concentrations of nutrients such as phosphorus (0.03-0.05 mg/L) and nitrogen (0.78-1.03 mg/L).

The sediments were dominated by detritus and silt, with smaller amounts of boulder, cobble, bedrock, pebble, filamentous algae, gravel, sand and clay also present; samples taken from below the surface were black silts that had a strong manure or anaerobic odour, and released sulphide when tested during each sampling period, indicating that the sediments lacked oxygen and were a harsh environment for most burrowing species to survive in. Over 10 cm of fine silt covered the bottom of the channel and a considerable amount of bank erosion (over 50%) occurred at the site, which appeared to have been caused by cattle accessing and trampling the banks and channel in autumn; stock appeared to have been excluded from accessing the stream in spring.

A large amount of phytoplankton was present in spring (chlorophyll a ranged from 1.6-10.7 µg/L) and filamentous algae (*Cladophora* and *Spirogyra*) was prominent because it covered over 10% of the channel in both seasons. A larger area (over 35%) of the creek was also covered by a range of aquatic plants, which included floating (*Spirodella* and *Azolla*), submerged (*Callitriche*) and emergent macrophytes (*Typha*, *Cotula*, *Juncus*, *Eleocharis*, *Isolepis* and introduced *Rorippa* and *Rumex*); the extent of algal and plant growths at the site support the nutrient enriched status of this creek. The riparian zone generally lacked any trees and consisted of weedy understorey shrubs (Gorse and Blackberries) over introduced grasses and herbaceous weeds. The surrounding vegetation near the creek comprised cropping and grazed paddocks with a few scattered gums.

[Close](#)

Special environmental features

The only significant environmental values of the creek were the presence of a threatened native fish and a flow-dependent blackfly in spring; presumably these species moved into the catchment in response to high flows during the wetter, winter or early spring months of the year.

[Close](#)

Pressures and management responses

Pressures	Management responses
Livestock having direct access at the site and upstream (causing sediment erosion and adding excessive nutrients).	The Adelaide and Mount Lofty Ranges NRM Board's land management program encourages and promotes managing land to improve water quality. This includes incentives for waterway and wetland fencing to exclude or limit stock from entering riparian zones.
Limited riparian zone vegetation at the creek and upstream (reducing habitat quality, increasing sediment erosion).	The Adelaide and Mount Lofty Ranges NRM Board's land management program encourages and promotes managing land to improve water quality. This includes incentives for revegetation programs around waterways and wetlands and stock exclusion as well as educating landholders about the importance of riparian vegetation in managing soil erosion.

Pressures	Management responses
Widespread introduced weeds in the riparian zone at the site and upstream (reducing habitat quality).	The Adelaide and Mount Lofty Ranges NRM Board has several pest plant (weed) mitigation and control programs. They work closely with landholders to control weeds on their property and to help stop the spread to other properties and waterways.

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Further information

Gallery

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Inverbrackie Creek, near Woodside 2016 Aquatic Ecosystem Condition Report

 epa.sa.gov.au/reports_water/c0032-ecosystem-2016

Condition overview

Key points:

- Permanent flowing stream in autumn and spring 2016
- Sparse [macroinvertebrate](#) community lacking any rare or sensitive species
- Water was moderately fresh, [turbid](#) and slightly coloured, and enriched with [nutrients](#)
- [Riparian](#) vegetation consisted of weedy shrubs over introduced grasses



Area map

About the location

Inverbrackie Creek is a moderately sized stream that rises to the north and east of Woodside in the southern Mount Lofty Ranges, and flows west into the Onkaparinga River, to the south of Woodside. Grazing modified pastures (53%) was the main land use in the 2,589 hectare catchment upstream from the site sampled, with smaller areas used for irrigated pastures and horticulture, cropping, roads, residential housing, plantation forestry, dams, irrigated cropping and native vegetation. The site selected for monitoring was located in the lower reaches of the stream, off the Woodside–Nairne Road, over one kilometre south of Woodside, upstream from the bridge.

[Adelaide and Mount Lofty Ranges NRM Regional Summary 2016](#)

In summary

The creek was given a Poor rating because the site sampled showed evidence of major changes in [ecosystem](#) structure and moderate changes to the way the ecosystem functions. There was clear evidence of human disturbance at the site due to nutrient enrichment, the mobilisation of fine [sediment](#), and the extent of weeds in the [riparian zone](#).

[Close](#)

Findings

A sparse community of at least 21 species of macroinvertebrates was collected or seen from the creek (13 species in autumn and 15 in spring), 3.5 m wide and up to 50 cm deep, in autumn and spring 2016. The creek consisted of mostly still to slow-flowing pool [habitats](#) connected by tiny areas of faster-flowing, shallower [riffle](#) habitats in both seasons sampled. The community was dominated by large numbers of mites, amphipods (*Austrochiltonia australis*) and water boatmen. Smaller numbers of native and introduced snails, shrimp, beetles, chironomids, mosquitoes, waterbugs, and dragonflies were also found. No flow-dependent species were seen in the small riffles that were present at the site. All macroinvertebrates collected were tolerant and generalist species that are well adapted to tolerate and thrive in organically polluted streams, and each has a wide

distribution throughout the agricultural areas of South Australia. No rare or sensitive species were recorded. Yabby holes were seen along the wet banks of the stream.

The water was moderately fresh ([salinity](#) ranged from 510-1,460 mg/L), well oxygenated (66-116% saturation), [turbid](#) and slightly coloured, and with moderately high concentrations of [nutrients](#) such as [phosphorus](#) (0.04-0.08 mg/L) and [nitrogen](#) (0.63-0.76 mg/L). Froth was also present at the site in autumn.

The [sediments](#) were dominated by [detritus](#) and silt, with smaller amounts of boulder, bedrock, cobble, pebble, [filamentous algae](#), sand and clay also present; samples taken from below the surface were black clays and silts that were [anaerobic](#), and released sulfide when tested during each sampling period, indicating that the sediments lacked oxygen and were a harsh environment for most burrowing species to survive in. Over 10 cm of silt covered the bottom of the channel and a considerable amount of bank erosion (up to 50%) occurred at the site, which appeared to have been caused by cattle accessing and trampling the banks and channel.

A large amount of [phytoplankton](#) was present in spring (chlorophyll *a* ranged from 1.27-6.58 g/L). Filamentous algae (*Cladophora*) covered over 10% of the channel in both seasons. The same area of the creek was also covered by a range of aquatic plants, which included floating (*Azolla*), submerged (*Callitriche* and *Crassula*) and emergent macrophytes (*Typha*, *Persicaria*, *Juncus*, *Phragmites*, *Mimulus*, *Isolepis* and the introduced *Rorippa* and *Rumex*). The riparian zone generally lacked any trees and consisted mainly of weedy shrubs and introduced grasses. The surrounding vegetation comprised grazing paddocks.

[Close](#)

Special environmental features

No significant environmental values of the creek were apparently in 2016, however this site has provided habitat for a threatened native fish in previous years.

[Close](#)

Pressures and management responses

Pressures	Management responses
Nutrient inputs to the creek from numerous diffuse sources (leading to extensive growth of algae and aquatic weeds)	The Adelaide and Mount Lofty Ranges NRM Board land management program encourages and promotes managing land to improve water quality. This includes working with industry and landholders to ensure efficient use of fertilisers and discuss ways to reduce runoff of nutrients into waterways.
Livestock having direct access at the site and upstream (causing sediment erosion and adding excessive nutrients)	The Adelaide and Mount Lofty Ranges NRM Board 's land management program encourages and promotes managing land to improve water quality. This includes incentives for waterway and wetland fencing to exclude or limit stock from entering riparian zones.
Limited riparian zone vegetation at the creek and upstream (reducing habitat quality, increasing sediment erosion)	The Adelaide and Mount Lofty Ranges NRM Board 's land management program encourages and promotes managing land to improve water quality. This includes incentives for revegetation programs around waterways and wetlands and stock exclusion as well as educating landholders about the importance of riparian vegetation in managing soil erosion. The Board also partner with local government to deliver a number of watercourse revegetation projects across the region.

Pressures

Management responses

Widespread introduced weeds in the riparian zone at the site and upstream

The [Adelaide and Mount Lofty Ranges NRM Board](#) has several pest plant (weed) mitigation and control programs. They work closely with landholders to control weeds on their property and to help stop the spread to other properties and waterways.

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Further information

Gallery

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