WATER WAYS
CONSULTING LTD

CANTERBURY COAL: ELF PROJECT

BUSH GULLY ASSESSMENT

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INTRODUCTION

1.1 Background

Canterbury Coal (2013) Ltd is seeking to expand coal mining operations at their coal mine into Bush Gully in the Wainiwaniwa River catchment, Canterbury. The North ELF project seeks to construct a waste rock storage area in Bush Gully, a valley adjacent to the coal mine on the hill slope between Bush Gully and Tara Stream. The extension area is rough pasture with a small tributary of Bush Gully forming a valley that can be used for storage of the waste rock. The waste rock facility also includes two sediment retention ponds at the downhill end of the facility to capture runoff from the waste rock store. It is expected that for the majority of the time this water storage pond will be only partially full to maximise sediment settlement prior to any discharge. Within the ELF rock site the waste rock will be progressively compacted and sealed with site rehabilitation occurring as work progresses. ELF site runoff undergo acid neutralisation by lime dosing at the pond as required and will also pass through a mussel shell bed bioreactor to provide acid mine drainage (ADM) treatment Regular water testing will determine dosing requirements. At this time it is also envisioned that option of pumping acid waters back to the mine water treatment system, that is situated within the Tara Gully water catchment, will be available if required.

The proposed location for the North ELF is generally considered to have low ecological value as it is rough pasture. However, the critically threatened fish, Canterbury mudfish (*Neochanna burrowsius*) (Goodman et al 2014) has been reported from a number of location within Bush Gully (e.g., Harding et al 2006, Golder 2014) and this fish may be present in the vicinity of the storage facility.

1.2 Report Scope

This report provides the results of a 2016 fish and habitat survey in Bush Gully and its tributaries and provides an assessment of effects of the ELF project on Canterbury mudfish and other aquatic values of the Bush Gully catchment.

2 METHOD

The aquatic values of Bush Gully and its tributaries in the vicinity of the ELF site where surveyed in 2014 by Golder Associates (Golder 2014). These sites and additional areas along Bush Gully and its tributaries were revisited in 18 July 2016. A daytime site walk was undertaken to assess habitat quality along Bush Gully and the tributaries. This survey assessed habitat availability for fish in the ELF Project tributary and in the first 2 km downstream along Bush Gully. The condition of the stream bed and riparian zone vegetation was recorded. Stream channel width and depth was recorded for the ELF tributary. The data provided by Golder (2014) was also used to provide information on habitat conditions of Bush Gully

A fish survey was conducted along Bush Gully and tributaries by night time spotlighting (Figure 1). Fish observed were identified to species level, but were not caught or measured. An estimate of abundance and population health was made from the observed and fish counts.

Figure 1: ELF Project (blue and brown shaded areas) with stream survey reaches (red lines) and Golder (2014) ecological survey sites (green stars).

Macroinvertebrate communities were not resurveyed and the data from the Golder (2014) survey was used to provide an assessment of the likely macroinvertebrate community present downstream of the ELF site.

3 RESULTS

3.1 Bush Gully Tributary

The Bush Gully tributary rises just below the ridgeline (420 m attitude) and descends to its confluence with Bush Gully at 320 m on the Bush Gully valley floor. The tributary sub-catchment is all rough grazed pasture. Woody shrubs; gorse, manuka, and coprosomas, are present although most these were dead presumably due to herbicide spraying (Figure 2). Wetter areas in the subcatchment are apparent and *Juncus* rushes are common across the hillside. A stream channel exists for much of the length of the gully with some wetland plants, the most of obvious of which was large but often dead *Carex secta* plants (Figure 3).

Figure 2: Bush Gully tributary catchment with dead woody vegetation and rough pasture.

For the majority of the length of the Bush Gully tributary could be considered a wet seepage zone with water depths up to 2 cm deep. The seepage width varies and ranges from less than 0.5 m in the upper steeper reaches to approximately 2 m in the lower reaches where the valley floor widens before the confluence with Bush Gully Stream. The wet areas are generally firm and pasture grasses cover the channel. Three pools were observed in the lower reaches, all approximately 10 cm deep and well shaded by vegetation (Figure 4). Water was observed flowing at some sites along the channel and flow was estimated to be less than 1 L/s.

Figure 3: Bush Gully tributary with Carex and Juncus plants along the stream channel.

Figure 4: Pool habitat in the Bush Gully tributary.

Aside from these pools there was no habitat in the stream that appeared suitable for fish.

Prior to the fish survey Bush Gully was walked from upstream of the tributary confluence downstream for approximately 1.5 km. During this stream walk two key observations were made. The access tracks running along the valley floor crossed Bush Gully six times. The upper three

crossing all had perched culverts (Figure 5). The three downstream culverts currently provide good fish passage. In addition, a further perched culvert was present in the lower reaches of the Bush Gully tributary.

Figure 5: Perched culverts along Bush Gully.

Recent stream channelization work had also been conducted along Bush Gully from approximately 5 m downstream of the middle perched culvert to the most downstream perched culvert (Figure 7). This reach starts about 40 m downstream from the confluence of Bush Gully and the ELF tributary. A short section of unmodified habitat is present downstream of the second perched culvert and this includes a 2 m long scour pool immediately downstream of the culvert. The channelization also extends an unknown distance upstream along the main upper branch of Bush Gully that was outside the intended survey area. Downstream of the perched culverts the stream morphology indicated that channel clearance work had previously occurred in a number of areas and little unmodified habitat existed in the survey reach.

Figure 6: The channelised section of Bush Gully.

Figure 7: The location of perched culverts and channel modification areas.

It was also evident that since the Golder (2014) survey of the upper reaches of Bush Gully a substantial access road has been constructed along the valley floor. This access road generally has unvegetated margins and there are also large areas of bare ground beside the road and alongside the stream (Figure 8). There are also several small channelized and culverted tributaries of Bush Gully along the access road (Figure 8). These areas combined with the instream works and upstream plantation forest harvesting have created large areas of eroding soils and appear to be responsible for the presence of large deposits of instream sediment that were common along the whole survey reach.

Figure 8: The access road and cleared ground (left) and channelised and culverted tributary (right).

3.2 Fish Survey

Spotlight survey extended from upstream of the upper most perched culverts downstream along Bush Gully to the boundary of the farmland and the plantation forest approximately 1.5 km downstream of the Bush Gully confluence. The pools in the Bush Gully tributary and wetted habitat downstream to the confluence with Bush Gully were also spotlighted. Spotlighting downstream of the channelized reach was less effective in the pool habitat due to suspended sediment reducing visibility to approximately 0.5 m meaning deeper pools could not be effectively surveyed. However, deep pool habitat was rare so this limitation applied to less than 5% of the survey area.

The survey failed to locate any fish in the Bush Gully tributary. No fish were observed in the sections of Bush Gully upstream of the two upstream perch culverts. A single Canterbury mudfish, less than 100 mm in length, was observed in the scour pool immediately downstream of the second perched culvert. No further Canterbury mudfish were observed in the channelized reach down to the third perched culvert. Downstream of the third culvert five Canterbury mudfish were observed, three together in one pool and two individual fish in separate pools. All these Canterbury mudfish appeared to be greater than 100 mm long. No further fish observed along the whole survey reach.

3.3 Golder (2014) Fish, Macroinvertebrate and Water Quality Data.

Golder (2014) survey was conducted in November 2013 and at that time the upper reaches of Bush Gully were describes as a linear wetland with a series of pools either connected by marshy wetland areas or disconnected from other wetted habitat. Cattle were observed grazing the stream banks and trampling the wetland areas during this survey leading to considerable damage to the stream habitat. Pool depth was up to 0.3 m deep.

Gee minnow traps were used to sample fish in these pools and caught five Canterbury mudfish in the vicinity of the confluence of the two main branches of Bush Gully (Figure 1). Trapping downstream below the third perched culvert caught four Canterbury mudfish. At these two sites over 100 upland bullies were also caught.

The macroinvertebrate communities sampled in Bush Gully all indicated poor aquatic habitat and/or water quality. Molluscs and crustaceans dominated the communities with oligochaetes and some Diptera also present.

Water quality measured indicated dissolved oxygen levels were low (range 27-64 % saturation), conductivity was high (267-349 µS/cm) and pH was near neutral (range 7.1-7.4). the lowest dissolved oxygen levels and highest conductivity was recorded at the most upstream site in the minor branch of Bush Gully near the ELF tributary.

3.4 Ecological Value Assessment

The proposed site for the ELF in the Bush Gully tributary appears to be a seepage and intermittent water course, not perennial flowing stream habitat. This assessment visited the site during damp winter conditions when surface water is expected to relatively high. At this time very little fish or stream invertebrate habitat was present and no fish were observed in the small area of available pool habitat. The stream vegetation is also significantly modified by grazing, herbicide use and modifications due to channelization and track construction in the lower reaches. The tributary is not considered habitat for the threatened Canterbury mudfish.

Downstream of the ELF site in the main stem of Bush Gully Stream the stream habitat is extensively modified by channelization activities, track crossings and the impact of grazing animals. Furthermore, recent channel and access road construction work have subjected the stream to substantial fine sediment inputs. Existing stream crossings with perched culverts also prevent upstream fish passage in the upper reaches of Bush Gully. The Golder (2014) study indicated the habitat and water quality were poor and that in dry periods the stream ceases to provide continuous flow. Significantly, the two fish surveys differed markedly in that upland bully were common in November 2013, but were completely absent in July 2016. This would indicate the stream ceased to provide suitable habitat for bullies at some time in the last two and half years. Drought impacts, the effects of stream channelization, or a combination of the two are likely to have led to the loss of upland bully. Canterbury mudfish also appeared to have declined markedly in the reaches upstream of the perched culverts. If the single individual observed is the only Canterbury mudfish present in this reach then the fish is functionally extinct in the upper reaches of Bush Gully. The perched culverts will also prevent upland bullies and Canterbury mudfish from recolonizing of the upper reaches of Bush Gully. The stream downstream of the ELF site is heavily impacted current farming and forestry activities, natural low flows and stream modifications. At this time, as these impacts are on-going, habitat and water quality in Bush Gully Stream will remain poor.

4 ASSESSMENT OF EFFECTS OF THE ELF PROJECT

4.1 Potential Effects

The construction of the ELF facility could have a range of potential effects including:

- Loss of fish and aquatic invertebrate habitat;
- Loss of stream habitat;
- Loss of wetland habitat;
- Downstream suspended sediment effects on Bush Gully;
- Release of acidic waters from the ELF site to Bush Gully; and
- Release of water with low dissolved oxygen concentration.

4.2 Assessment of Effects

4.2.1 Loss of stream habitat

The site survey found no stream habitat exists within the ELF footprint. The only pool habitat occurs downstream of the proposed sediment retention ponds, but even this habitat is not expected to retain water year round. The majority of the wetted area to be infilled are seepage areas and an intermittently flowing stream course rather than perennial stream habitat and no perennial stream habitat loss is expected to occur.

4.2.2 Loss of fish and invertebrate habitat

The fish survey of the Bush Gully tributary found no fish and almost no fish habitat was present. The recent fish and habitat surveys of pool habitat were made during a relatively wet time of year when aquatic habitat is expected to be at its greatest extent. During dry periods fish habitat is expected to be extremely limited or more likely absent. Similarly, during winter there is wetted habitat that may be used by aquatic invertebrates. However, it is expected that this wetted habitat will be extremely limited or absent during dry periods. The vegetation along the tributary has also been degraded by stock grazing. Any invertebrate fauna supported by the water course is also expected to be degraded and comprised of taxa that tolerate these degraded conditions.

The construction of the ELF facility is not expected to cause the loss of any fish habitat, including habitat for Canterbury mudfish. There will be some loss of aquatic invertebrate habitat but as this habitat is expected to support a degraded community of common tolerant taxa the loss in not expected to be significant.

4.2.3 Loss of seepage habitat

The ELF facility will lead to the loss of the seepage areas the extends as a narrow strip up the Bush Gully tributary. This area is degraded by stock and pasture development activity. The associated vegetation is also degraded due to grazing and the presence of a range of introduced pasture grasses. Golder (2014) noted the general area to be considerably drier than the conditions observed in July 2016 and it is expected that for much of the year the seepages are drier than observed in July 2016 and may be completely dry at times. Therefore, while some wetted area loss will occur this will be limited to a degraded area that is expected to experience extended dry periods.

4.2.4 Suspended sediment discharges

The ELF project includes a dam and suspended sediment retention ponds that are designed to retain fine sediment in stormwater runoff. These sediment retention ponds are expected to provide a discharge of best practice quality that restricts any suspended sediment discharges. It is possible that fine suspended sediment will be discharged from the storage pond. However, the volume of water is expect to be small and also a relatively small component of the wider Bush Gully Stream flow due to the small catchment area of the ELF site subcatchment. The downstream area of Bush

Gully are currently degraded due to, long term stock access and more recently stream channel modifications and roading works that have created a stream with substantial deposits of fine sediment. The addition of small amount of suspended sediment is unlikely to further degrade the instream habitat given the current suspended sediment discharges. Furthermore, during dry periods any discharge from the settlement ponds is likely to empty to dry stream reaches and be rapidly evaporated or absorbed into the soil. Pasture grasses growing along the tributary stream channel are then also likely to bind this sediment.

Small discharges of fine sediment discharges are not expected to impact upon the Canterbury mudfish. The current population upstream of the most downstream perched culvert is potentially just the single fish seen. Unless restoration action is undertaken and/or fish passage is restored Canterbury mudfish will no longer be present in the upper reaches of Bush Gully. As noted above during drier periods of the year Bush Gully has intermittent flow and any discharge from the ELF pond will be lost before the water and sediment can flow downstream to reaches occupied by Canterbury mudfish. In the event that Canterbury mudfish are restored to the upper reaches of Bush Gully and the stream banks rehabilitated to prevent the current suspended sediment discharges then the major Bush Gully tributary will provide a relatively high volume of clean water to dilute any suspended sediment discharges and no effects on Canterbury mudfish would be expected.

4.2.5 Acidic water discharges

Of most concern would be effect of acid mine water discharges on Bush Gully fauna including Canterbury mudfish. With respect to the effects on Canterbury mudfish O'Brien & Dunn (2007) reviewed the available information on Canterbury mudfish pH tolerance. This review indicated that Canterbury mudfish are generally found in water with a pH between 6 and 8, with the occasional population reported in water with a pH closer to 5. O'Brien & Dunn (2007) also concluded that Canterbury mudfish are the least tolerant mudfish to acidic pH which they attributed to the adaption of other mudfish to more acidic soils and peat wetlands. Golder (2014) reported the pH in Bush Gully to be 7 or greater and this would mean pH could become more acidic without impacting on mudfish. The ELF project includes an adaptive management process for preventing discharges. This can include active dosing of water in the sediment retention ponds and passive treatment systems including the mussel shell reactor (MSR). Working MSRs can reduce both water acidity and the heavy metal load. This means that water from the ELF retention ponds that flows through the MSR will not increase the acidity of Bush Gully.

4.2.6 Discharges of anoxic water

Water processing in the MSR lowers the dissolved oxygen concentration, at times to very low levels Crombie et al (2011). Therefore, treating AMD via the MSR can remove the acidic effects but will release anoxic water. This oxygen depletion zone will be most pronounced immediately downstream of the MSR in the Bully Gully tributary. Reaeration will increase oxygen content as the water flows downstream and dilution of the low dissolved oxygen water will occur at the two stream confluences not far downstream. Therefore, the effects will be most severe in the intermittently flowing tributary where aquatic life is limited and no Canterbury mudfish or upland bullies have been reported.

If low dissolved oxygen level water flows into the Canterbury galaxiid inhabited reach Golder (2014) report that the dissolved oxygen in this area can be as low as 2.8 mg/L (27% saturated). This dissolved oxygen concentration is the same as the mean dissolved oxygen value reported by Crombie et al (2011) for a MSR outflow. Crombie et al (2011) does note that the minimum dissolved oxygen level from the MSR study was 0.5 mg/L. With respect to any MSR at ELF site the MSR will

only discharge water when there is flow in the tributary, for instance, after rainfall. At these times the there will be flow in the large tributaries and mainstem areas of Bush Gully Stream. With reaeration and dilution the dissolved oxygen level of the water will increase before it reaches any Canterbury mudfish habitat. It is note worth that the Golder (2014) low dissolved oxygen measurement occurred when Bush Gully Stream was reduced to a very low flow conditions, a time when discharges from the ELF would be minimal if present at all. Finally, before entering the Canterbury mudfish reach the ELF water flows through two culverts, the second of which has a free full drop that should aid reaeration (Figure 9).

Figure 9: Free fall ouflow from culvert upstream of Canterbury mudfish habitat.

4.3 Summary of Assessment of Effects

The site will overlay an intermittent stream and seepage area but no other effects are expected. The construction of the ELF facility will not lead to the loss of any Canterbury mudfish or any other fish habitat. Treatment of the water from the ELF site will restrict suspended sediment, acidic water and heavy metals in the runoff. Water with low dissolved oxygen levels is expected to be released but reaeration and dilution is expected to restrict the reach of water course affected to areas of the intermittent tributary stream. Canterbury mudfish are also expected to tolerate any low dissolved oxygen discharges as these already naturally occur in their habitat. The current state of Bush Gully Stream and the Canterbury mudfish population in reaches near to the ELF facility means the mine facility will have very little or no impact on the Canterbury mudfish population. It is also expected that discharges from the ELF site will not restrict rehabilitation of Bush Gully for Canterbury mudfish.

5 RECOMMENDED MITIGATION

5.1 Canterbury Mudfish

The ELF facility is not expected to impact on the Canterbury mudfish population of Bush Gully Stream. In the event that no rehabilitation work is undertaken in Bush Gully to improve fish passage and reduce the effects of the current land use and stream management it is expected that Canterbury mudfish will cease to occupy the stream in the reaches closest to the ELF site. No mitigation for Canterbury mudfish for the construction of the ELF facility is recommended. With regard to the low dissolved oxygen outflow from the MSR monitoring of this should be undertaken and if required a reaeration structure such as a small water fall at the existing culverts could be enhanced to increase turbulence and reaeration.

5.2 Water Course Loss

Some low quality stream and seepage habitat will be lost during the construction of the ELF facility. Where possible significant trees such as large cabbage trees may be relocated to areas outside the ELF. Any subsurface runoff could be discharged to adjancet water courses or to the tributary downstream of the ELF and will supplement water flows in these areas. There are also several very similar tributaries of Bush Gully adjacent to the ELF site that have similar seepage features. Fencing a section of similar seepage/stream habitat to provide protection could be considered. This would provide a water course area that would support a range of wetland flora and fauna without the ongoing impacts of stock grazing. However, this will require the agreement of the landowner.

6 SUMMARY

Canterbury Coal (2013) Ltd are proposing to construct a waste rock storage facility in a tributary of Bush Gully. The facility will comprise of a large waste rock dump that will, over time, fill the tributary gully. The ELF includes a sediment retention ponds at the bottom of the gully to capture suspended sediments in runoff. Water discharged from the sediment retention ponds will pass through a passive water treatment facility, the MSR, before entering Bush Gully Stream. Dilution of any discharges will occur a short distance downstream of the discharge point where the stream is joined by first the minor branch of Bush Gully Stream and then the major branch of Bush Gully Stream. However, of concern is the potential effect of the discharge on the threatened fish Canterbury mudfish that is known to be present in the upper reaches of Bush Gully Stream.

Fisheries investigation of Bush Gully have been conducted in 2014 and 2016 to assess the state and distribution of the fish populations. Between 2014 and 2016 the fish populations of Bush Gully have declined with the apparent complete loss of upland bully and a decline in the abundance of the rarer Canterbury mudfish. A combination of drought effects and channel clearance work is believed to have caused these declines. At present, no upland bully are present in areas potentially affected by any discharges from the ELF facility. A single Canterbury mudfish was located near to the retention pond area. This fish appears to be isolated from other Canterbury mudfish located further downstream by perched culverts that prevent upstream fish passage. Therefore, while Canterbury mudfish are present in the stream close to the discharge point unless other undiscovered mudfish are present the population is functionally extinct above the most downstream perched culvert.

In the event Canterbury mudfish are more abundant than found in the recent survey or restoration work restores the mudfish to the upper reaches pH tolerance for the mudfish has been assessed. Water quality data from Bush Gully Stream found pH was 7 to 7.4. Canterbury mudfish are generally found in waters with pH ranging from 6 to 8, and occasionally in water with a pH of up to 5. The ELF project discharges are intended to be circum-neutral and are not expected to create acidic conditions in Bush Gully Stream. However, the MSR is expected to discharge water with low dissolved oxygen concentrations. This water will be reaerated naturally as it flows downstream and water from confluence inflows will also dilute the low dissolved oxygen water. This low dissolved oxygen water is expected to be within the range tolerated by Canterbury mudfish, especially as they will not be exposed to the water at the discharge point rather at some distance downstream. Using the historic range of Canterbury mudfish from 2014 approximately no habitat would be subject to the discharge before dilution occurs where Bush Gully tributary joins the minor branch of Bush Gully Stream.

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