THE IMPACTS OF BUSHFIRES FOLLOWING A FLASH FLOOD EVENT IN THE CATCHMENT OF THE OVENS RIVER

SUMMARY

A flash flood in the Buckland River following the bushfires in the summer of 2003 resulted in a major fish kill in the Ovens River and threatened town and rural water supplies. This report describes the effects of this event and the resulting ‘slug’ of sediment on water quality, fish populations and other aquatic life in the Ovens River. A number of different agencies responded to the incident, providing advice, tracking the sediment ‘slug’ as it travelled down the Ovens River, and carrying out follow-up monitoring to assess its effects on river condition and water supply.

The risk to the health of the Ovens River still exists, however it will lessen with time. Native fish populations, in particular, were badly affected and may take many years to recover. This report explores the potential risks to aquatic ecosystems and water supplies following the event and how the State Government’s Bushfire Recovery Program will help to better understand and manage these risks.

THE EVENT

An intense storm on 26 February 2003 (approximately 150mm of rain fell in a one-hour period) in the catchment of Dingo Creek, a tributary of the Buckland River in north-east Victoria (Figure 1) resulted in a flash flood. This catchment had been heavily burnt during the summer 2003 bushfires and, as a result, large quantities of ash and unconsolidated soil were washed into the Buckland River. This material formed into a ‘slug’ of muddy water (Figure 2) which travelled rapidly down the Buckland River and entered the Ovens River upstream of Myrtleford. As the sediment ‘slug’ moved downstream, water quality rapidly deteriorated, posing a serious threat to town water supplies, stock water and to fish and other aquatic life in the Ovens River.

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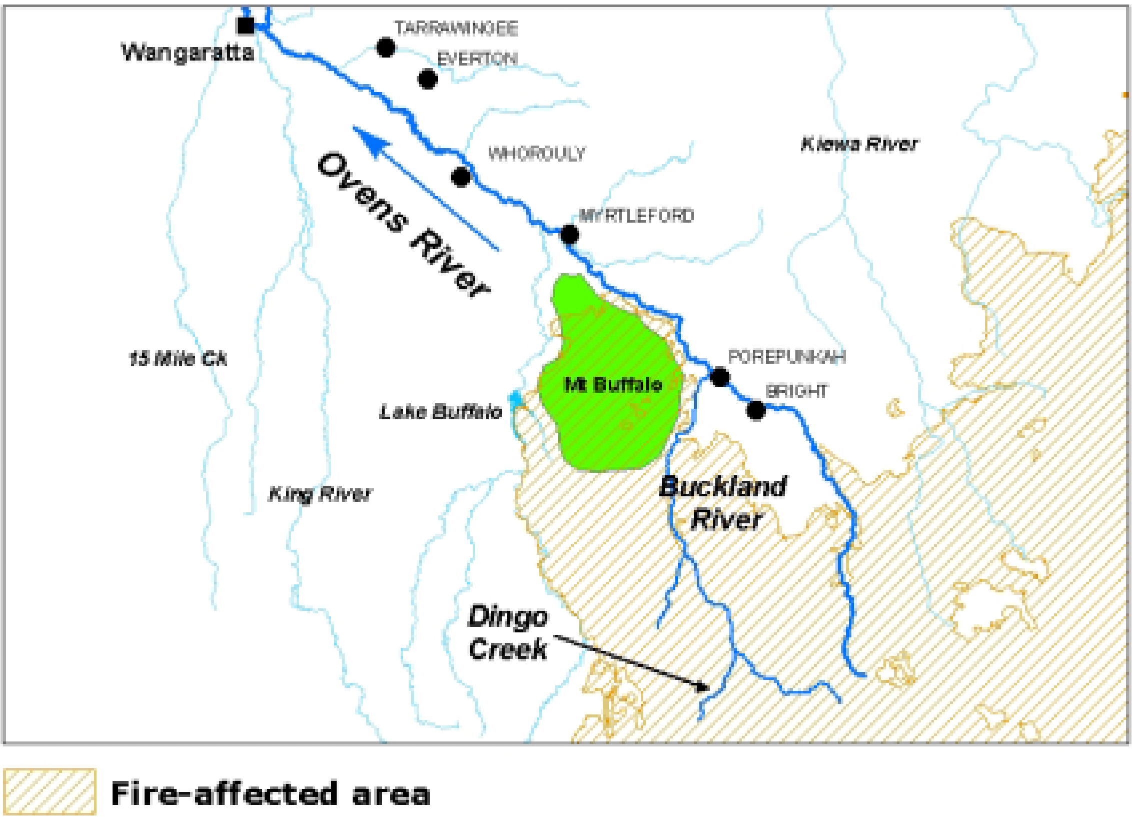


Figure 1: Map of the Ovens and Buckland rivers (EPA 2003)

Figure 2: The sediment 'slug' in the Ovens River at Whorouly (EPA 2003)

The significant and rapid increase in flow over a short period of time is highlighted by the following 'hydrograph' (Figure 3), generated from flow measurements at a site in the lower reaches of the Buckland River.

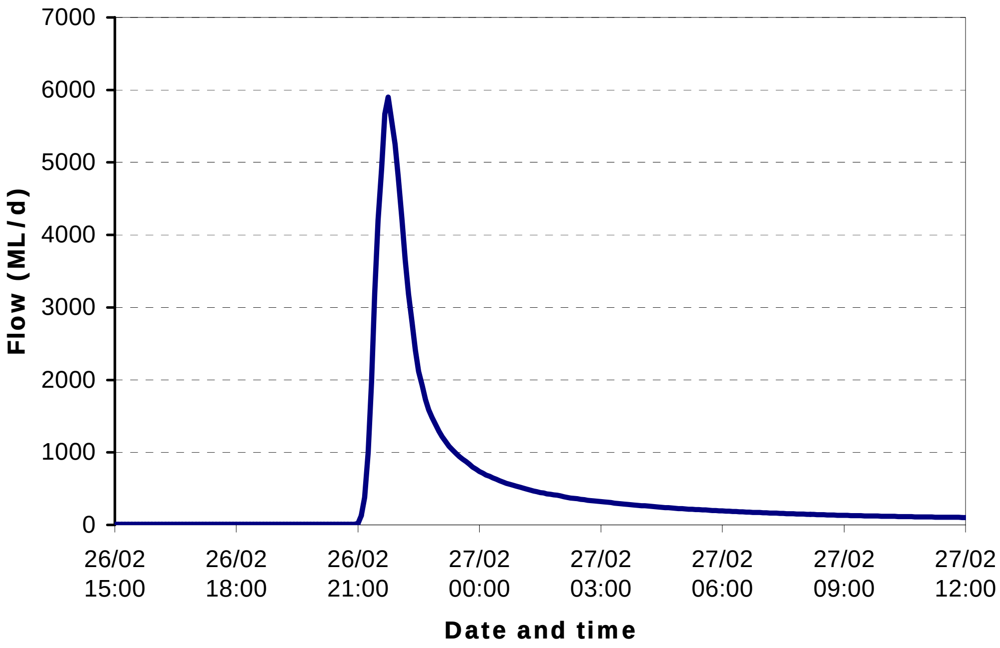


Figure 3: Hydrograph of the Buckland River at Harris Lane (Goulburn Murray Water 2003)

RESPONSE AND COORDINATION

The Buckland River flooding event required an immediate response from relevant agencies, particularly given the potential risk to town and rural water supplies and aquatic ecosystems. EPA Victoria, North East Water, Goulburn Murray Water (GMW), the North East Catchment Management Authority (NECMA) and the Department of Sustainability and Environment (DSE) worked, and continue to work, collaboratively in response to the event.

Within 24 hours of the flash flood occurring, EPA's North East Region office had received numerous reports of fish kills in the Ovens River. EPA implemented its fish kill response protocol and initial notification of relevant parties was undertaken. The number of fish deaths observed by agencies turned out to be quite small as, in many cases, adjacent landholders had collected and disposed of fish as they were found. Further investigation by DSE revealed that at least 70 native fish, over one hundred yabbies and crayfish and a large number of introduced fish, particularly carp, had been killed. Water quality measurements were taken by several agencies and EPA and DSE collected fish samples for post-mortem analysis. EPA and

North East Water continued monitoring water quality in the Ovens River as the 'slug' moved downstream.

Although water authorities had given considerable thought to the way they would respond to this type of event, the magnitude of the event had not been predicted. The ability to supply sufficient potable water to the many townships along the Ovens River was the primary concern of the water authorities. Providing advice to landholders diverting water for irrigation and stock purposes was also important. While it was clear that the sediment 'slug' would have a significant impact on water quality for town supplies, livestock and irrigation, the likely improvements in quality as the 'slug' moved downstream could not be quantified. It was also difficult to predict how quickly it would move downstream. This was critical for North East Water, as it would define their operational arrangements and decisions for many weeks. The availability of this type of information was limited, posing a major threat to their ability to manage the risk to water supplies.

IMPACTS OF THE SEDIMENT 'SLUG'

Effects on water quality

The sediment 'slug' had a dramatic impact on water quality. Following the flash flood, there were very large increases in turbidity in sections of the Ovens River, peaking at 70,000 NTU on 27 February 2003 at Myrtleford. By comparison, turbidity levels in the Ovens River are usually well below 10 NTU. Suspended solid levels, which are typically less than 6mg/L in this river system, peaked at 33,000mg/L, that is 3.3 per cent solids. Dissolved oxygen concentrations of less than 1mg/L can lead to fish deaths and significantly impact on other aquatic organisms. In the sediment 'slug' dissolved oxygen levels were very low, dropping to 0.1mg/L. These conditions contrasted sharply with water quality downstream of the sediment 'slug', which was more typical of the normal condition of the river.

While the effect of the sediment 'slug' on water quality in the Ovens River was dramatic, the severity of the impact was short-lived. For example, as the sediment 'slug' passed Tarawingee between 3 March and 4 March, dissolved oxygen levels were very low for approximately 24 hours. Water quality improved relatively quickly (Figure 4) after the front had passed, although dissolved oxygen levels were still significantly less than those normally observed in the river.

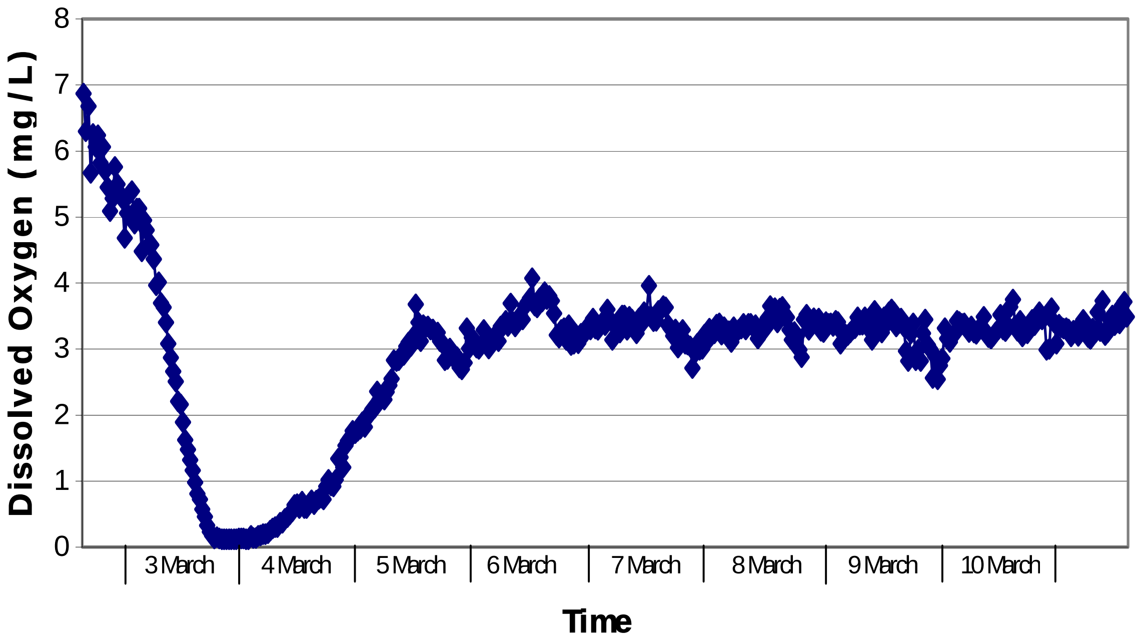


Figure 4: Changes in dissolved oxygen concentration in the Ovens River at Tarrawingee before, during and after the sediment 'slug' (DSE 2003)

The peak in turbidity was also relatively brief and decreased in magnitude along the Ovens River (Figure 5). The sediment 'slug' took 12 days to reach Wangaratta by which time turbidity levels had dropped to 2,370 NTU. This decrease was a result of large amounts of fine sediment dropping out of the 'slug' as it travelled downstream. This fine sediment was deposited on the streambed in its wake.

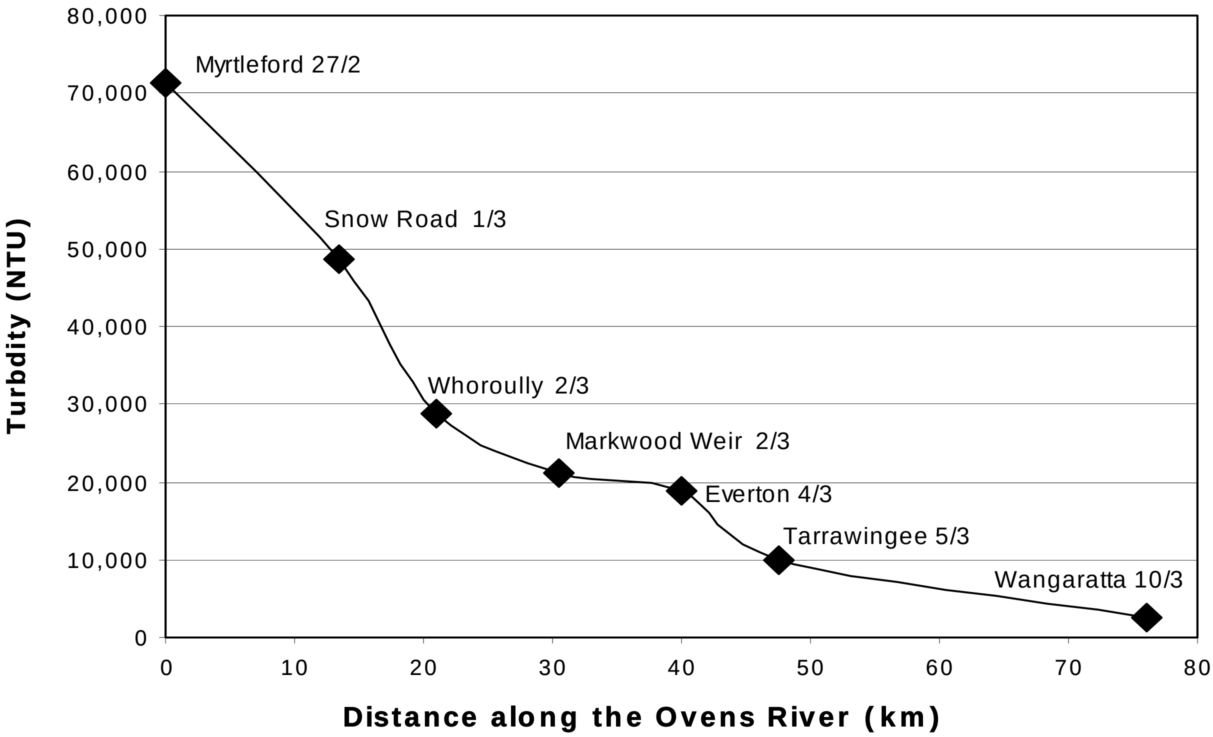


Figure 5: Decrease in peak turbidities along the Ovens River (North East Water (2003)

Effects on aquatic life

The 'slug' of ash and sediment had an immediate impact on the living communities of the Ovens River. Carp, redfin, Murray cod and trout cod were observed struggling for oxygen at the water surface in the Myrtleford-Whorouly section of the river. Several fish were found dead along the sides of the river including Murray cod, river blackfish, smelt and carp. Spiny freshwater crayfish were seen walking out of the water to avoid the effects of the sediment 'slug'.

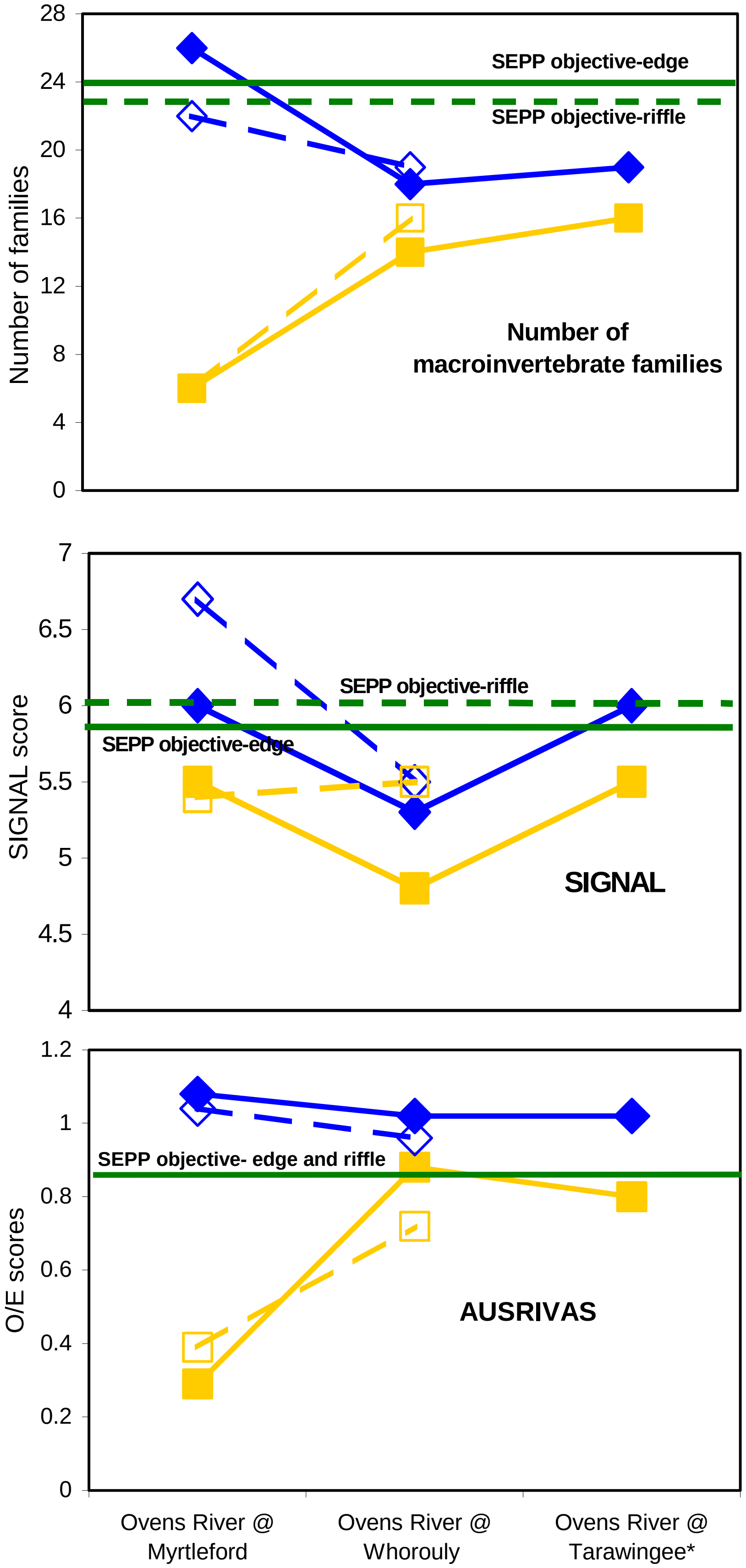
Native fish populations were severely impacted by the sediment 'slug'. A post-event survey by DSE in March 2003 found a 98 per cent reduction in native fish abundance in the Buckland River. A similar pattern was observed in the Ovens River between Porepunkah and Myrtleford. For example, there were no native fish at a site on the Ovens River 1.5km below its confluence with the Buckland River where more than 200 native fish had been found the previous year. At this time, it is not clear whether the reduction is a result of fish migrating out of the area to avoid the sediment 'slug' or a large-scale fish kill. However, the magnitude of the decrease in abundance following the event suggests it may be several years before native fish stocks in the Buckland and Ovens rivers return to pre-event levels.

Aquatic macroinvertebrates (such as insects, snails and worms) are also commonly used to assess the health of rivers. They were useful in this case because, like fish, they are a direct measure of how the sediment 'slug' affected the living communities of the river. They are also an important food source for fish, yabbies and birds. Although some are tolerant of poor water quality, more sensitive aquatic macroinvertebrates are eliminated by factors such as low dissolved oxygen and high levels of suspended solids and organic matter.

EPA collected aquatic macroinvertebrate samples at three sites on the Ovens River downstream of the Buckland River during March 2003, after the sediment 'slug' had passed. Samples were collected from the edges of the streams in areas of little or no current ('edge' habitat) and from areas of moderate to fast current ('riffle' habitat). Since these sites were also sampled in autumn 2002, a comparison can be made with this pre-'slug' data.

The macroinvertebrate results were analysed using three biotic indices: number of families (a simple measure of diversity); SIGNAL (an indicator of water quality); and AUSRIVAS (a measure of community structure). It is useful to include these separate indices because they each say different things about the impact of the sediment 'slug' on the macroinvertebrate communities of the Ovens River. For example, SIGNAL is more sensitive to water quality impacts, whereas AUSRIVAS is more sensitive to impacts on habitat quality. Results were compared to State Environment Protection Policy (Waters of Victoria) objectives, that is the levels at which the aquatic ecosystem is protected. In this instance, the objectives are used to provide a general indication of condition, since assessment against the SEPP objectives requires combined seasons data from autumn and spring.

Figure 6: Macroinvertebrate results from autumn 2002 (blue, solid line = edge, dashed line = riffle) and March 2003 (yellow, solid line = edge, dashed line = riffle) (EPA 2003).



* no riffle habitat

The results show an obvious decline in the health of the Ovens River following the passage of the sediment ‘slug’, with a major impact on the aquatic macroinvertebrate community downstream of the Buckland River (Figure 6). It is likely that these impacts would have been greatest close to where the Buckland River enters the Ovens River upstream of Myrtleford (Figure 1) and results show that the site at Myrtleford was clearly the worst affected. Far fewer macroinvertebrate families were found at this site in March 2003 compared with the previous autumn and SIGNAL and AUSRIVAS scores were much lower, indicating a severe impact. Scores were also lower than the previous autumn at Whorouly and Tarrawingee although the decline was not as severe as that observed at Myrtleford.

As the sediment ‘slug’ moved down the Ovens River towards Wangaratta, sediment and ash settled out, particularly in slow-flowing areas such as pools, stream edges and around snags. It is likely that the smothering of habitat in pools and scouring of riffles, together with breathing difficulties caused by very low oxygen levels were the main reasons for the lower number of macroinvertebrate families found in the Ovens River at Myrtleford.

Below Myrtleford the macroinvertebrate community appeared to have been less affected. The release of approximately 45 megalitres of relatively clean water into the Buffalo River from Lake Buffalo by Goulburn Murray Water may have helped to improve water quality conditions and provide a source of macroinvertebrates to recolonise the river after the sediment ‘slug’ had passed. In addition, progressively less sediment dropping out of the ‘slug’ on its way down the river would have decreased the scouring and sedimentation impacts.

The aquatic community reflects conditions at a site for several weeks to months before sampling takes place and the decline in the condition observed in autumn 2003 may also reflect effects of ongoing drought and very low flows in the Ovens River prior to sampling. While the effects of the drought no doubt contributed to the condition of the Ovens River in March 2003, it is considered that the severity of the decline observed at Myrtleford was primarily due to the impacts of the sediment ‘slug’.

Effects on upper catchment geomorphology

The catchment area at the source of the slug, around the upper tributaries of Dingo Creek, has been significantly affected by the rainfall which triggered this event. Approximately 15 tributaries of Dingo Creek, many of which only flow during the winter months, have had large amounts of rock debris deposited within their channels. In some cases this rock has formed a 'plume' into Dingo Creek, blocking the flow and causing the creek to change course. It is highly unlikely that this rock will make any significant movement downstream in the short to medium term, given the amount of force that would be required to move it. Any potential long-term effects of the deposition of this rock debris are currently unclear.

Effects on rural and urban communities

The impact of this event on town water supplies and other diverters was significant. Town water supplies that were already under strain as a result of the drought were further impacted by poor water quality. Rural diverters had to contend with the impacts of turbid water on their pumping and irrigation equipment as well as the poor quality of water supplies for stock and domestic use. Goulburn Murray Water played an important role in assisting landholders during the event. GMW was able to advise diverters about water availability and quality. As irrigators were already on water restrictions, this event further restricted their activities.

The population of Wangaratta is approximately 18,000 people and it relies on the Ovens River to supply all of its town water. The sediment 'slug' in the Ovens River posed an obvious threat to the town's water supply, and while turbidity decreased as suspended sediment dropped out of the 'slug' as it moved downstream (Figure 5), it was still above 2,000 NTU when it reached Wangaratta on 10 March.

Treatment plants struggled to cope with the huge suspended sediment loads, and where storages existed, town water use was restricted to extend the life of existing supplies. Stage 4 restrictions were introduced on 6 March in order to reduce demand for water and allow the water treatment plant more time to deal with the water quality problems. Water was trucked into towns to further supplement and dilute the water extracted from the Ovens River in combination with extra water treatment and additional filtration. This allowed North East Water to provide sufficient potable water to Wangaratta and to the townships along the Ovens River throughout the danger period. The treatment process reduced turbidities in the Ovens River from 2,370 NTU (the peak of river turbidity at Wangaratta) to 0.4 NTU when it left the treatment plant, well within the guideline values for potable water. With each subsequent rainfall event however, sediment has been resuspended into the river which is requiring ongoing management of water supply activities.

RISKS TO AQUATIC ECOSYSTEMS AND WATER SUPPLIES

An inter-agency workshop held at EPA's Centre for Environmental Sciences prior to the event in February 2003 discussed the likely impacts on aquatic ecosystems as a result of the summer bushfires. This resulted in the development of a risk-based matrix for identifying and prioritising the major issues associated with the impacts of bushfire on aquatic ecosystems. This tool was useful in identifying the risks to the Ovens catchment following the fires and the flash flood's resultant sediment 'slug'. The major risks are discussed below:

Sediment slugs

The intense heat of bushfires can cause changes to the structure and chemistry of soils in affected areas. Together with the loss of terrestrial vegetation, this results in a build up of loose sediment and ash, which can be rapidly washed into waterways during heavy rainfall events. As vegetation re-establishes, the amount of loose sediment decreases and future rainfall events will carry less sediment to waterways. This suggests that although more events of this type may occur in the Ovens catchment in the next few months, their impact will not be as great. However, heavy rainfall will still have the potential to wash substantial amounts of sediment into waterways until vegetation is fully re-established.

A large amount of fine sediment has been deposited in the Ovens River following the sediment 'slug'. Much of this material may be re-suspended during high flows. This suspended matter can affect aquatic ecosystems by decreasing the amount of light available for photosynthesis by plants, clogging fish gills leading to respiration problems, and scouring and abrasion of aquatic life and habitat. The deposition of fine sediment will also decrease the amount of habitat available for fish spawning and smother fish eggs. As silt is washed downstream, this will present a real risk to native fish recruitment in the lower Ovens River, an important breeding site for Murray cod and trout cod.

A further concern is the possible development of a sand 'slug'. Sand has a greater potential to damage habitat than the silt currently presents, as the fineness of silt means that it will most likely be washed out of the system over a relatively short time period (that is, several years). A sand 'slug', on the other hand, may take many more years to move through a system, effectively smothering large areas for extended periods. It is believed that the sand 'slug' in the Snowy River, for example, was sourced from bushfires many years ago.

Changes in hydrology

The bushfires are also likely to affect water flows from previously forested sub-catchments of the Ovens River. Until the natural vegetation re-establishes, flows from these catchments will be greater, particularly during heavy rainfall events when the soil's capacity to hold water is quickly exceeded. This may last for some time. Beyond this, the regeneration of forest may result in lower levels of run-off since young forest tends to use and intercept more water than old-growth forest and streamflows in burnt areas of the Ovens catchment may decrease.

Toxic effects

There are a number of potential toxic effects from bushfires but at this stage, little is known about the risk to Australian aquatic ecosystems. Bushfires may release a number of toxic chemicals which may eventually enter waterways. Volatile oils released by burning vegetation may also be toxic to aquatic life. Toxic effects can also occur when metals and biocides attached to soil particles are washed into waterways. Many of these effects can be subtle and may not be apparent in the short-term. For example, a number of these chemicals may bioaccumulate over time in biota and through the food chain so that their effects may not be seen for some time. It is not possible to definitively establish the risk to aquatic ecosystems in the Ovens catchment posed by toxic chemicals at this time but initial analysis of water and sediment samples following the sediment 'slug' suggests the immediate risk is low.

Algal blooms and water supplies

Since the peak event in late February-early March 2003, water quality in the Ovens has remained a concern. Although a great deal of the sediment has dropped out of the water column, much of the riverbed downstream of Porepunkah is covered in fine silt and mud particles, ready for re-suspension each time flows increase. When this happens, suspended sediment levels will again rise and pose a risk to supplies of water for domestic and stock use downstream. Nutrients attached to sediment particles may also be mobilised increasing the risk of algal blooms, especially in the lower Ovens River.

Food web changes

The bushfires may lead to changes in the structure of aquatic ecosystems. Where vegetation has been burnt to the stream edge in the upper catchment, the reduced input of organic matter and increase in light and temperatures may lead to a more algae-dominated ecosystem. Because the different species in aquatic ecosystems are interlinked in a complex food web, this will affect other biota in the web. For example, an algae-dominated ecosystem will favour macroinvertebrates that graze on algae.

RECOVERY FROM THE EFFECTS OF BUSHFIRE

In response to the bushfires in Victoria in 2003, the State Government launched the Bushfire Recovery Program. The program supports strategies for protecting catchments and water resources, repairing damaged infrastructure assets and restoring ecological and cultural assets.

Although evidence suggests streams usually return to pre-fire conditions within five to 20 years depending on the severity of the fires, there is still a great deal we don't know about the recovery of aquatic ecosystems from the effects of bushfires. The challenge is to gain a greater understanding of recovery mechanisms and timescales, and EPA and DSE are working together to assess the impact of fire on river health and threatened or high value species.

The use of macroinvertebrates is well established as an indicator of river health. Monitoring by EPA of a number of fire-affected sites in the north-east of Victoria will not only provide information on the short-term impacts of fire, but also the timeframe for recovery of the aquatic ecosystems. More subtle effects may be detected by quantitative monitoring at sites where DSE autosamplers are in place and allow impacts on river health to be related to fire-related changes in water quality.

DSE and the Water Studies Centre of Monash University are examining the fate and effect of key contaminants transported from burnt areas to downstream water bodies, and the impact of the fires on water yields from burnt catchments. Modelling will be used to determine the likely impact on sediment and nutrient yield from burnt catchments and the potential magnitude of the impacts on ecosystems and water quality.

The Ovens River sediment ‘slug’ had a dramatic impact on native fish populations and it may be many years before native fish stocks in the Buckland and Ovens rivers return to pre-sediment ‘slug’ levels. Scientists from the Arthur Rylah Institute (ARI) of DSE have secured funding to study and manage the recovery of the native fish fauna and develop native fish recovery plans for the Buckland and Ovens Rivers. Other funding priorities for the ARI include determining the extent of sediment in the river and estimating the time it will take for sand and silt to move through the system. ARI also intend to visit the Dingo Creek catchment to determine the long-term impacts of the rock debris deposited in the upper tributaries of this creek.

PARTNERSHIP AGENCIES

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FURTHER INFORMATION

CRC for Catchment Hydrology Bushfire website: http://www.catchment.crc.org.au/bushfires/

The Bushfire Recovery Program: http://www.info.vic.gov.au/bushfire/recovery.htm

North East CMA Bushfire Recovery Program community information leaflet:
http://www.necma.vic.gov.au/docs/news/media/CMA_FlyerV2.pdf