Memo

Subject	Options analysis for Tree T1, AMCOR paper mill, Alphington
Distribution	City of Yarra
Date	12 August 2019
Project	P119162.10_Tree_Collpase_Bank_Slump_Investigation

1 Introduction

The City of Yarra has engaged Alluvium Consulting Australia Pty Ltd (Alluvium) to investigate recent tree collapse and bank slumping events on the Yarra River adjacent to the former Amcor paper mill site in Fairfield. The subject site adjoins the right bank of the Yarra River and is the subject of an urban renewal / development project by Glenvill.

Alluvium has convened an expert panel to review the issues associated with the bank slump and tree collapse. Alluvium submitted an initial memo to identify any immediate issues arising from a site inspection including potential for imminent tree collapse and additional information requirements.

The purpose of this memo is to identify management options for tree T1 covered in our previous memo on this topic.

The memo covers following:

1. A description of the processes leading to tree collapse
2. Development of a set of objectives for tree T1
3. Identification of constraints to the attainment of those objectives
4. Options to manage the subject tree

2 Background

The subject site is located on the right bank of the Yarra River upstream of Dights Falls, immediately upstream of the Chandler Highway and adjacent to the former Amcor paper mill. The riverbank at the subject site is located within freehold land. It is understood that a 30metre wide riparian corridor will be secured for public access and use as a component of the proposed redevelopment project.

The riverbank at the subject site comprises a lower terrace (including walking path) adjacent to the Yarra River water edge and a steep embankment up to the former industrial and proposed residential lands. A portion of the lower terrace comprises fill at site of a prior confluence of the Yarra River and a small creek. The steep embankment was established during the period of site occupation by Amcor, to the 1% AEP (approx.) flood elevation, to prevent flood inundation of the site. The steep embankment contains uncontrolled historic fill material.

The lower terrace and steep embankment have been revegetated with non-indigenous native trees. However, the edge of the riverbank comprises indigenous river red gums (*Eucalyptus camaldulensis*), likely to be from natural regeneration.

The riverbank on the lower terrace has been subject to recent slumping. There are three large (but not mature hollow bearing trees) River Red Gum trees within and adjacent to a recent bank slump. One of these trees has

fallen into the river and is currently lying across the Yarra River. Two other trees (T1 and T2) have been identified as at risk of collapse.

A further River Red Gum fell into the river in January 2019. This tree has been removed leaving the root ball in the bank. Other bank slumps are present and other trees along the waterway reserve may be at risk.

The mechanisms for the cause of the bank slumping is to be the subject of detailed investigations into the extent and cause of the problem and the identification of mitigation measures.

It is understood that City of Yarra and members of community wish to explore options to retain Tree T1. This memo sets out those options.

3 Potential process leading to tree collapse

The expert panel, convened by Alluvium to assesses the issues, has identified the potential processes leading to the collapse of trees at the site and has identified the following factors that could contribute to the collapse of T1.

3.1 Bank slump

The primary driver of T1 collapse will most likely be further ground movement destabilising the tree. Tree T1 has tilted due to bank slump and unless this issue is addressed, there is an imminent (weeks to months) risk of Tree T1 falling. Further slumping will lead to further tilting of the tree and the ultimate collapse of the tree

The expert panel has identified a rise in groundwater in lower the terrace of the Yarra River at the subject site as the likely cause of the bank slumping. The expert panel noted the poor condition (and death) of some of the introduced vegetation on the lower terrace and lower levels of the steep embankment. While a decline in vegetation condition could be the result of many factors, it is consistent with the elevated groundwater levels, indicating water logging of roots.

In addition to the tilting, the root system of T1 has most likely been damaged as a result of the bank slumping. The damaged root system reduces the ability of the tree to:

- collect and transport water to the foliage.
- Support the tree at a tilt and from falling in wind events

Initial baseline investigations suggest that riverbank erosion at site is unlikely to be the cause of the slumping. However, stream erosion has the potential to remove recently slumped material leading to further slumping and tree movement.

3.2 Wind load

The impact of wind load on trees depends on wind velocity, diameter and volume of stem, height of tree, crown area, steam breakage strength, root system (depth, weight, and diameter of roots), and strength of roots and soils. If the tree has a root system inconsistent with the size of the crown, there is a significant risk of tree collapse due to uprooting. Due to recent slumping, the root system of Tree T1 has been compromised. Heavy wind load under current root conditions can destabilise the tree, leading to collapse.

However, T1 is in a relatively well protected location and has other trees around it offering wind protection. Therefore, the tree is not highly exposed to wind, and while contributing to the threats, the wind load may not be the immediate primary driver of collapse.

3.3 Drought stress

The root system of T1 has been disturbed by the bank slump. This will have an impact on the tree's ability to transport water to the crown. The effect of this will be seen when the water demand of the tree increases in

summer and the tree experiences seasonal drought stress. The tree will be expected to lose much of the foliage and may begin to shed branches. If the root system is not able to supply adequate water to the tree it will most likely die within two summers. Ongoing shedding of limbs will create an ongoing risk to access. An ongoing decline in the condition of the tree will also increase the WHS risks to arborist and others tasked with the ongoing management of the tree.

4 Objectives

Council meeting (30th July) and ongoing discussion with council officers have assisted the expert panel identify objectives for the management of Tree T1. The objectives can be listed as:

4.1 Ecological value

Tree T1 (River red gum) is an indigenous native tree that has provided a healthy arboreal habitat. The tree is a character species of the endangered EVC56 Floodplain Riparian Woodland, the natural vegetation community for this section of the Yarra River. The tree has not matured into a hollow bearing tree and so is not providing valuable nesting habitat.

The tree can provide ecological value as a standing dead "stag". Standing dead trees provide rooting and nesting sites especially if they have hollows in them.

Trees falling into rivers introduces large wood structures to the river and can form primary instream habitat features. The Yarra River has a low density of large wood. The tree could provide significant ecological value as instream large wood.

4.2 Aesthetic value of tree

The Tree T1 together with other trees along this reach of the river provides significant aesthetic value to riverbank and walking path. As an indigenous species to the area, the tree contributes to the character of the river and riparian zone.

4.3 Public access

The public access to riverbank has been restricted since past few months as a result of the bank collapse and risk of tree fall. The current bank slump and condition of Tree T1 prevents access to the site. Return of public access is sought for the site.

4.4 Protection of riverbank

An uncontrolled collapse of Tree T1 will compromise the existing lower terrace of the riverbank. The tree also contributes to the surcharge / load on the riverbank.

The collapse of tree will result in further loss of bank material and damage to the path. The uncontrolled loss of the lower terrace will also compromise the stability of the steep upper bank. The loss of the lower bank and steep upper bank would result in significant loss of property, with potential release of the uncontrolled historic fill material into the Yarra River.

However, the root ball of the existing tree can offer stability to the bank and could be kept if the tree is removed.

4.5 Protection of other trees

If T1 falls in an uncontrolled manner it may fall onto adjacent trees and shrubs damaging them. The size of this tree means other trees could be lost on the site following an uncontrolled failure of the tree. Protection of other trees will be important for the site.

5 Constraints on options

Constraints that impact on the feasibility of options include:

5.1 Work health safety

The use of large machinery, on the lower terrace with accompanying surcharge and vibration could increase the likelihood of collapse and may pose a work health and safety risk for operators.

Similarly, any tree work that requires an arborist to climb the tree can pose some work health and health safety risks. Retention of the tree, that results in an ongoing decline in its health, will increase the WHS risk to staff tasked with the management of the tree

5.2 Environmental regulations

A planning permit is required for native vegetation removal. However, clause 42.03-3 of the state planning provisions provides for an exemption to the requirements for a planning permit for vegetation removal to enable emergency works.

A review of the risk assessment (likelihood and consequence framework) used by Ryder Arboriculture has not changed the low risk assessment to the public safety. With pedestrian controls in place, this situation (while not ideal) may not constitute an emergency.

However, the subject tree in its current form threatens the bank stability. Council officers, have advised that the subject riverbank has undergone significant further movement over the weekend (10 and 11 August 2019), refer figure below. The subject bank is active. Further bank slumping can be expected over the forthcoming days and weeks.

The loss of the lower terrace and steep upper bank would result in significant loss of property including the walking path, with accompanying adverse outcomes for the Yarra River including release of uncontrolled historic fill material. Removal of the tree T1, to reduce the mass of the tree, and the uncontrolled collapse of the tree would meet the requirements of emergency works to protect the riverbank.

Tree T1 on and related bank slump 12 August 2019

5.3 Timeliness of action

Timeliness of actions are essential in the identification of the best available option for management of Tree T1. Based on the recent bank movement over the last few days, actions to address the risks should be undertaken with a level of urgency over a period of days rather than months.

6 Option assessment

6.1 Possible interventions

A set of possible interventions for management of T1 are set out below. All the following interventions will require the input from specialist contractors and a work safe assessment to ensure a safe method is applied. These interventions have been combined into three alternate management options in section 7 of this report.

Restrict site access
Ongoing signage and fencing of the path to prevent the public access along the waterway reserve. This is required while the tree is in an unstable state. Signs in the river to inform people on the water are also required. This must be in place in the short term until the site can be made safe.

This is an unlikely to be a long-term intervention option as the public will require access along the river to make use of their public spaces.

Fall tree
Tree to be cut down in a controlled manner ensuring adjacent vegetation is not impacted. The trunk and main branches to be kept intact as much as practical to enable the tree to be used for instream habitat. The root ball to be retained intact to assist the protection of the bank

Install main trunk and large branches in river as a habitat snag
The tree can be used as large woody debris (snag) in the river. This will provide desirable instream habitat which is at low levels in this section of the Yarra River.

Approval from Melbourne Water will be required for this intervention. The installation of large wood is consistent with Melbourne Water's management and priorities for waterways improvement and subject to appropriate placement, approval will most likely be given for this action.

Brace tree
Install cables and land anchors to stabilise the tree. This will provide support to the tree against wind loads until significant ground movement occurs. If further ground movement occurs the bracing will most likely fail.

This intervention may require machinery to install the land anchors.

Infill slumping cracks
Infilling the slumping cracks with a sandy-loam soil will assist in stabilising the site and help protect the roots from exposure to air. This will also provide a substrate for roots to regrow into assisting in future growth of the tree. Infilling the slump cracks will also reduce water access to the slumped soil.

Reduce crown of tree
Lop tree to remove branches over public access paths and to even the weight distribution in the crown. This will also reduce the water demand of the tree and potential drought stress it will experience in summer.

After lopping, the tree it will produce epicormic shoots to replace the reduced crown. These can be prone to dropping and pose an ongoing safety hazard. Regrowth on the tree will need to be managed over time to maintain public safety.

- It will involve arborists climbing the tree.
- A permit is required to lop the tree.

Kill tree, reduce crown and retain upright as habitat tree
This aims to retain the tree as a stag for future habitat. The tree will have most of the branches removed and be treated with herbicide to prevent regrowth and hazards from epicormic growth. Holes can be bored into the tree structure to initiate hollows for nesting.

This will not reduce weight on the bank and the stag will most likely fall if there is further ground movement.

Rock armour the bank
Rock rip rap can be used to prevent the loss of slumped bank material via river erosion processes.

To limit the safety risks, this work would need to be undertaken from the river via a barge. Placement of rock in this manner is not generally used to prevent slumping from banks as the saturated bank material can still pass through the rock. As a consequence, the approach may limit the erosion of slumped material but may not prevent further bank slumping.

Melbourne Water approval will be required to undertake rock armouring.

Sheet pile the bank
Sheet piling could be used to 'prop up' the riverbank. Stabilising the bank using sheet piling will have less intrusion into the river channel than rock and may be more successful in preventing further slumping than rock beaching. The sheet piling would also need to be installed from a barge on the river

However, sheet piling introduces a highly unnatural engineered feature into the river which is both visually and ecologically unacceptable in this location. The sheet piling may also further damage (cut) the root material of existing vegetation

Melbourne Water approval will be required for sheet piling. It is unlikely that sheet piling would be approved for installation at the site. Although this has not been tested with Melbourne Water.

Reduce slumping potent by managing soil moisture
Further soil movement and slumping will be activated by increased ground water flowing to the location. If the ground water is intercepted the risk of slumping may be mitigated.

This option requires further detailed investigation of the ground water and geotechnical conditions to ensure this is the driver for soil movement.

7 Option package

The development of the option for the removal or retention of T1 has considered the site context.

Tree T1 raises a problem at this location due to the level of public access. In addition, the location has been modified in the past with vegetation clearing, replanting, land filling and land use changing over time. The current and planned use of the waterway reserve is for public use, amenity and waterway health. The waterway is expected to be in a naturalistic state but not a fully intact ecological condition. The trees along the river provide support to the waterway aquatic environment, habitat to birds and arboreal animals and visual amenity for the reserve users.

Three alternate options have been developed for T1 (the tree within the recent bank slump).

7.1 Option 1: Fall the tree and install as instream habitat

Interventions

- Fall the tree
- Place the tree in river as aquatic habitat
- Infilling of slump cracks
- Retain the root ball for bank protection
- Mange soil moisture

Advantages	Limitations:
Short term • Opens potential for access of river frontage to community • Increases instream habitat • Reduces damage to bank due to tree falling in uncontrolled manner • Reduces risks to other trees from an uncontrolled fall • Removes safety hazard to river users • Predictable outcome.	• Tree is not standing/ loss of existing aesthetic and ecological values
Long term (>10 years) • Access to site is unrestricted • Future planning can provide outcomes for the community • Habitat improvement in waterway.	

Discussion

This option addresses the current safety issue presented by T1 and provides an opportunity to reopen the existing walking path to the community (refer discussion below). It provides a certain outcome including the potential addition of large wood habitat in the river. The option is not confounded by other issues related to the ground stability and success is not dependent on other issues being resolved. This option is consistent with recommendations of arborists that have visited the site.

The requirement to obtain a permit for native vegetation removal does not apply to emergency works to reduce immediate risk to property. The active movement of the bank and the extent of damage to both property and the Yarra River, constitute 'an immediate risk to property' and enables activation of clause 42-03.3 of the state planning provisions, creating an exemption for emergency works.

Reopening of the walking path: While this option provides the opportunity for reopening of the walking path, significant further work will be required to provide safe public access. The extent of such work should be explored in subsequent investigations and reporting.

7.2 Option 2: Retain the living tree with possible engineering interventions

Interventions

- Rock beaching to protect slumped material from river erosion
- Bracing of the tree to enable safe river access, limit direction of tree fall and enable access to tree for crown lopping
- Infill slump cracks
- Reduce the crown (lopping)
- Ongoing monitoring of tree
- Ongoing maintenance of crown (if possible) if the tree suffers dieback
- Manage soil moisture
- Intermittent site access subject to tree condition and access for maintenance

Advantages	**Limitations:**
Short term • Tree could be alive, but is increasingly unlikely given recent ground movement	• Tree will be changed from current visual condition. • Uncertain outcome with ongoing likely collapse. • Limited public access • Ongoing safety hazard • No guarantee of tree survival, tree loss is imminent
Long term (2-5 years) • Tree may be retained on the site	• Ongoing survival of tree is not certain • Tree will fall or die and investment in retaining it will be lost • Ongoing site access constraint. • Ongoing safety hazard from tree of branches falling • Ongoing maintenance requirement • Tree is likely to fall

Discussion

This option partially addresses the current safety issue presented by T1. This option provides a short-term benefit with the outcome of delivering a living tree that may persist for some years.

However, the longevity of the tree would remain uncertain. The retained tree will have a compromised health and a changed visual appearance. The tree will also pose an ongoing safety hazard. The compromised tree is likely to continue to shed limbs. This may restrict access in the future and will require ongoing monitoring and maintenance commitments.

The success of this options is uncertain as is dependent upon the underlying ground stability issue being resolved. If the slump progresses the tree will fail regardless of the interventions applied.

7.3 Option 3: Retain the dead standing tree with possible engineering operations

Interventions

- Rock beaching
- Bracing
- Infill slump cracks
- Reduce the crown
- Restrict access
- Manage soil moisture
- Kill tree with herbicide

Advantages	Limitations:
Short term • Tree is retained vertically • Habitat is retained riparian zone • Local character is maintained to some extent	• Uncertain outcome • Restricted public access • Possibility of collapse with future ground movement • Limits options for future reserve plans
Long term (5-10 years) • Habitat is provided in riparian zone • Local character is maintained to some extent	• Ongoing persistence of standing stag is not certain • Tree may fall and investment in retaining it will be lost • Further damage to the bank.

Discussion

This option partially addresses the current safety issue presented by T1. The outcome of a standing stag on the site is uncertain. If this achieved it is likely to provide a 5-10-year ecological benefit to the riparian zone. Uncontrolled failure of the tree with further damage to the bank and adjacent vegetation is possible.

However, the tree will pose an ongoing hazard. This may restrict access in the future and will require ongoing monitoring and maintenance commitments.

The success of this option is uncertain as it is dependent upon the underlying ground stability issue being resolved. If the slump progresses, the stag is more threatened and may fail.

Recommendation

The success of Options 2 and 3 are uncertain. These options retain the tree at the current location in an altered state. However, they also retain a safety hazard on the site and will require ongoing maintenance input. Option 3 should be immediately dismissed as an unacceptable outcome as it provides limited benefits over Option 2

Option 2 seeks to retain the current aesthetic and ecological attributes of the existing T1. However, the crown of the tree would need to be modified and would pose an ongoing public risk as the condition of the tree declines and sheds timber. The option does not provide a practical and feasible solution to the risks at the site and is not recommended.

Option 1 (Remove the tree and retain trunk for habitat and root ball for bank protection) provides a predicable outcome for the site and enables most short- and long-term objectives to be achieved. While the loss of the tree will have some impact on the character of the site, this is the only option that provides for the practical and feasible resolution to the risks posed by the severely compromised tree T1. Option 1 is the only feasible option that addresses the immediate risk of damage to property (riverbank).

Option 1 is recommended for implementation as a matter of urgency. The active movement of the bank and the extent of damage to both property and the Yarra River, constitute 'an immediate risk to property' and enables activation of clause 42.03-3 of the state planning provisions, creating an exemption for emergency works.

While not essential for public safety, the option would also help to reduce risks to public safety. Until this option is enacted, site access control (walking and boating) must be in place to manage the site safety risks.