**REPORT**

# Expert Report - Mr Paul Stewart

*Panel Hearing - Greater Geelong Planning Scheme Amendment C395*

Submitted to:

**Norton Rose Fulbright**
Level 15, RACV Tower
485 Bourke Street, Melbourne VIC 3000

Submitted by:

**Golder Associates Pty Ltd**
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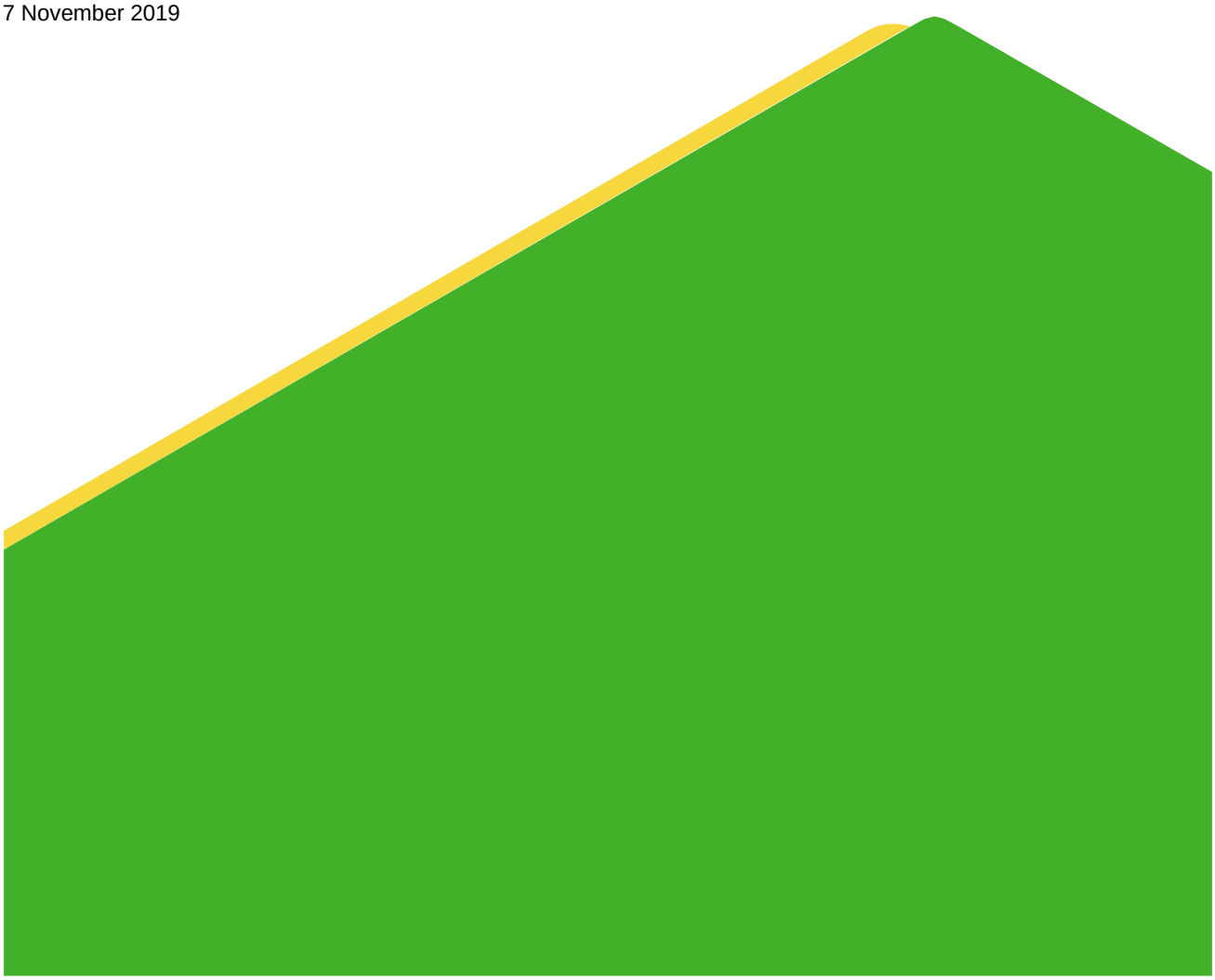
7 November 2019



# Distribution List

Norton Rose Fulbright - 1 electronic copy

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# Attachments

## FIGURES



**APPENDIX A**
WGGA Document titled 'Quarry to Lake Conversion'

## Particulars

1) This report has been prepared at the request of Norton Rose Fulbright by Mr Paul Stewart, Principal Geotechnical Engineer at Golder Associates Pty Ltd (Golder), at:

   Building 7, Botannica Corporate Park

   570-588 Swan Street

   Richmond, Victoria 3121

2) I am a Geotechnical Engineer, with the following qualifications and affiliations:

   a. BSc (Hons) Civil Engineering: University of Strathclyde, Glasgow (1978-1982)

   b. MSc Geotechnical Engineering: University of Newcastle upon Tyne (1984)

   c. Member of the Institution of Civil Engineers, United Kingdom (MICE,CEng)

3) I have 34 years of experience working on Civil Engineering and Geotechnical Engineering Projects in the UK, Asia and Australia. I am a Principal and a leader of Geotechnical services in the Melbourne office of Golder, having joined Golder in June 1997. I have experience on a wide range of projects which have included quarry rehabilitations, major road and rail projects, port facilities and industrial developments. On these projects, I have been responsible for the management of ground investigations and the provision of geotechnical design solutions relating to soil and rock slope stability, ground improvement and foundation design.

4) Norton Rose Fulbright provided me with a Letter of Instruction (the brief) seeking written advice that addresses the following items specifically:

   a. *The extent of current quarrying activities within the Western Geelong Growth Area and when they are anticipated to cease.*

   b. *The current status of quarry rehabilitation works with the Western Geelong Growth Area and the estimated timing for the completion of rehabilitation works following the cessation of quarrying activities; and*

   c. *The current status of quarry rehabilitation works for the '1930s quarry' and the estimated timing for the completion of rehabilitation works.*

5) I have been engaged by ABCL to assist it with quarry planning; rehabilitation planning; rehabilitation design; and rehabilitation construction compliance for the Batesford Quarry on an ongoing basis since 2009.

6) I have undertaken my most recent site inspection of the Batesford Quarry on Wednesday 23 October 2019, in the company of ABCL representatives, and this site inspection has also informed my statement.

7) I have made all the inquiries that I believe are desirable and appropriate and no matters of significance which I regard as relevant have to my knowledge been withheld from the Panel.

## Extent of Current Quarry Operations and Anticipated Closure

8) The Adelaide Brighton Cement Ltd (ABCL) Batesford Quarry operates under Work Authority WA3, as regulated by Earth Resources Regulation (ERR). The quarry comprises the existing 'current quarry' south of the Moorabool River, and a smaller former '1930s quarry' atop the escarpment north of the Moorabool River and south of the Midland Highway. My statement relates to both the 'current quarry' and the '1930s quarry'. Figure 1 attached shows an aerial view taken in September 2019 of the current extent of the Batesford Quarry and '1930s quarry'.

9) ABCL (including its predecessors) and McCann have operated the Batesford Quarry for over 100 years under a joint venture arrangement that will continue until the extractive industry operations cease and any outstanding rehabilitation obligations under extractive industry Work Authority 3 (WA3) are completed.

10) The Batesford Quarry comprises multiple parcels of land under various Certificates of Title, with those land parcels located within WA3 zoned as Special Use Zone (Schedule 7) under the Greater Geelong Planning Scheme (the Planning Scheme).

11) I am briefed that Amendment C395 to the Planning Scheme will, over a period of many years, enable the urban development of the Western Geelong Growth Area (WGGA), with the rehabilitated ABCL Batesford Quarry to form a centerpiece lake within the Framework Plan. Timing for the completion of the rehabilitation of the Batesford Quarry therefore has bearing on when the totality of the land use outcomes defined in the Framework Plan become realised.

12) I am advised by ABCL that quarrying in what is termed the '1930s quarry' commenced in 1890 and ceased in the 1930s and has not recommenced since. The location of the '1930s quarry' is shown on Figure 1. It is my understanding that no further quarrying will take place at this location and is awaiting final rehabilitation.

13) Within the current quarry, quarrying has ceased in aerial extent and depth in the areas referred to as the southern, western and northern escarpments. The extent of the rehabilitated southern, western and northern escarpments is shown on Figure 1. The eastern end of the current quarry is the active extraction zone and presents the final phase of quarry operations. Refer to Figure 1 for the current extent of the eastern end of the quarry.

14) I have consulted with ABCL and have been advised that the current average extraction rate is approximately half a million tonnes per annum. It is also my understanding that resource extraction operations at Batesford Quarry will cease around 2025.

## Status of Rehabilitation Works for the Operating Quarry

15) I have reviewed the ERR endorsed *Rehabilitation Plan for the Batesford Quarry* (Earth Tech, 2005), which has informed the progressive rehabilitation of the current quarry, which commenced in 2009.

16) Between 2009 and 2012, there took place borehole/test pit investigations, field compaction trials, slope and drainage design, the preparation of contract documentation for construction and the tendering process.

17) Construction commenced on the southern face of the current quarry in 2012, extending in a clockwise direction through the western and northern quarry faces, where it finished in early 2019, pending the cessation of resource extraction in the eastern end of the quarry. The rehabilitation of the southern escarpment comprised a cut and fill operation with the engineered fill being sourced at the southern and eastern ends of the current quarry. The rehabilitation of the western and northern escarpments was an exercise primarily in cut, with engineered fill only being placed at the far eastern end of the northern face.

18) Photos 1 and 2 attached show the southern, western and northern escarpments upon completion of rehabilitation. Note, in the process of the rehabilitating the northern quarry face, the quarry access haul road was also re-aligned.

19) The progressive rehabilitation of the current quarry means that approximately 75% of the rehabilitation has taken place. The remaining 25% will be completed upon the cessation of resource extraction at the eastern end of the quarry.

20) In order to support the expeditious rehabilitation of the eastern end of the current quarry, I am advised by ABCL that it will continue to progressively shape the slope faces through this final phase of the quarry operation. The rehabilitated eastern face is expected to be similar in form to the previous rehabilitated faces, comprising cut batters with minimal filling, plus appropriate benching and drainage.

21) Based on the construction rate for completion of the progressive rehabilitation of the southern, western and northern faces of the current quarry, I estimate that rehabilitation of the currently proposed eastern quarry landform would be completed within 1 year of ceasing resource extraction operations. My estimation is based on the fact that, when compared to the balance of the current quarry, the eastern escarpment of the quarry will be shallower relative to the surrounding natural landscape and will not require the same extent of cut and fill in order to shape and construct the rehabilitated slopes.

22) From my review of the Nolan-ITU Report (January 2002) titled ‘Batesford Quarry Groundwater Level Recovery Investigation’, I understand that achieving the final lake level presented in the Rehabilitation Plan may take up to 20 years from the time that groundwater suppression is ended, and the aquifer begins to recover.

23) The existing ERR endorsed *Rehabilitation Plan* details the final landform that is to be achieved through the rehabilitation of the current quarry. However, it is my understanding that the final landform at the eastern end of the quarry may vary from this in order to accommodate integration with the variety of land use outcomes envisaged for this area of the WGGA in the Framework Plan. This may include integration with:

    a. A beach-style lakeshore;

    b. Rowing sheds and rowing boat launch;

    c. Boardwalks; or,

    d. A reformed natural vegetated lakeshore.

    Figure 3 - 2033 on page 7 of the WGGA document titled ‘Quarry to Lake Conversion’ presented in Appendix A shows the potential extent of the eastern quarry rehabilitation.

Irrespective of the land use outcomes that may be established at the eastern end of the current quarry under the Framework Plan, it is my understanding that the rehabilitated landform beneath the predicted final lake water level would remain in general accordance with the landform presented in the existing ERR endorsed *Rehabilitation Plan*. The final rehabilitated landform above the predicted final lake water level could be revised and integrated with that landform below the water surface.

## *Status of Rehabilitation Works for the '1930s Quarry'*

24) I am advised by ABCL that quarrying in what is termed the '1930s quarry' commenced in 1890 and ceased in the 1930s and has not recommenced since. It is my understanding from discussions with ABCL, that no further quarrying will take place at this location and is awaiting final rehabilitation. Photo 3 attached shows the '1930's quarry' viewed from the southern side of the Moorabool River.

25) I have reviewed the existing ERR endorsed *Rehabilitation Plan*, which defines the landform rehabilitation outcomes for the '1930s quarry'. This effectively restores the northern escarpment of the Moorabool River along the south western edge of the '1930s quarry', while the balance of the quarry will be shaped to integrate with the generally flat-to-undulating landform north of the Moorabool River escarpment.

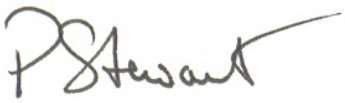
26) I have reviewed the proposed transport corridors included in the Batesford South Precinct, as shown in Plan 51 of the Framework Plan, which shows that the proposed western crossing of the Moorabool River in this precinct traverses the footprint of the '1930s quarry'. ABCL has advised me that it is advocating for the alignment of the Moorabool River crossing further to the west of the proposed alignment and outside of the footprint of the '1930s quarry'. Golder in coordination with ABCL are currently proceeding with the preliminary planning and preparation of tender drawings to enable potential commencement in 2020 of the rehabilitation of the '1930s quarry' in accordance with the existing ERR endorsed *Rehabilitation Plan*.

27) The design of the slopes along the south western edge of the '1930s quarry' and along the northern escarpment of the Moorabool River are analogous to the rehabilitated slopes already constructed in the current quarry. In this regard and based on the construction rate for the completion of the rehabilitated southern, western and northern escarpments, I estimate that rehabilitation of the '1930s quarry' in accordance with the existing ERR endorsed *Rehabilitation Plan* may be completed within 1 year of commencement.

28) It is my view that if the alignment of the proposed Moorabool River crossing was to remain as indicated in the Framework Plan, it will be necessary for ABCL to revise the design and specification for the rehabilitation of the '1930s quarry' in order for it to accommodate the road alignment and bridge infrastructure required for the river crossing. This would result in a delay in achieving the rehabilitation of the '1930s quarry'. The designs would need to be prepared and a revised Rehabilitation Plan submitted to ERR for endorsement through a Work Plan Variation to Work Authority WA3. In my experience, completing the designs and obtaining the relevant ERR, and potentially Council endorsement of a revised Rehabilitation Plan may add up to 2 years to the rehabilitation timelines.

# Signature Page

**Golder Associates Pty Ltd**



Paul Stewart
*Principal Geotechnical Engineer*

GCH/PS/gch-ps



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**LEGEND**

1 APPROXIMATE SITE PHOTO VANTAGE POINT LOCATION

**NOTE(S)**

1. REFER TO FIGURES 2 AND 3 FOR SITE PHOTOS.

**REFERENCE(S)**

AERIAL IMAGE DATED 14 SEPTEMBER 2019 SOURCED WITH PERMISSION FROM www.nearmap.com.au

0 250 500
1:10,000 METRES

CLIENT
NORTON ROSE FULBRIGHT

PROJECT
GREATER GEELONG PLANNING SCHEME AMENDMENT C395

CONSULTANT
GOLDER

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|---|---|
| YYYY-MM-DD | 2019-11-07 |
| DESIGNED | PDM |
| PREPARED | PDM |
| REVIEWED | PS |
| APPROVED | PS |

TITLE
**AERIAL VIEW OF CURRENT EXTENT OF THE BATESFORD QUARRY AND THE '1930's QUARRY'**

| PROJECT NO. | CONTROL | REV. | FIGURE |
|---|---|---|---|
| 107613104 | 064-R | 0 | 1 |

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ISO A3
0 25 mm

1 SOUTHERN ESCARPMENT

2 WESTERN AND NORTHERN ESCARPMENT

**NOTE(S)**

1. REFER TO FIGURE 1 FOR SITE PHOTOGRAPH VANTAGE POINT LOCATIONS.

CLIENT
NORTON ROSE FULBRIGHT

PROJECT
GREATER GEELONG PLANNING SCHEME AMENDMENT C395

CONSULTANT
GOLDER

| | |
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| YYYY-MM-DD | 2019-11-07 |
| DESIGNED | PDM |
| PREPARED | PDM |
| REVIEWED | PS |
| APPROVED | PS |

TITLE
**PHOTOS 1 AND 2: SOUTHERN, WESTERN AND NORTHERN ESCARPMENTS AFTER REHABILITATION**

| PROJECT NO. | CONTROL | REV. | FIGURE |
|---|---|---|---|
| 107613104 | 064-R | 0 | 2 |

3 1930's QUARRY

**NOTE(S)**

1. REFER TO FIGURE 1 FOR SITE PHOTOGRAPH VANTAGE POINT LOCATIONS.

CLIENT
NORTON ROSE FULBRIGHT

PROJECT
GREATER GEELONG PLANNING SCHEME AMENDMENT C395

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TITLE
**PHOTO 3: '1930's QUARRY' VIEWED FROM SOUTHERN SIDE OF MOORABOOL RIVER**

| PROJECT NO. | CONTROL | REV. | FIGURE |
|---|---|---|---|
| 107613104 | 064-R | 0 | 3 |

**APPENDIX A**

# WGGA Documents Titled ‘Quarry to Lake Conversion’

# Quarry to Lake
## Conversion

Western Geelong Growth Area

| Document Control and History | |
|---|---|
| Document | WGGA QUARRY TO LAKE CONVERSION INFORMATION |
| Version | 2.1 |
| Document Key | PACE15835BS |
| Status | DRAFT |
| Circulation | PUBLIC |
| Last Edited | 14-01-2019 |
| Release Authority | John Pelchen, Edward Jones |
| Doc Director | Nicholas Heath |

# Contents

# 1.0 Introduction

Quarry Site looking South East towards Fyansford

The Western Geelong Growth Area (WGGA) Framework Plan provides for the integration of a lake that will be formed in the rehabilitated former Batesford Quarry.

The lake will be an outstanding feature in the WGGA and will provide recreational opportunities for residents and the people of Geelong. The rehabilitation of the quarry and formation of the lake will lead to improved ecological values and general environmental improvements of the Moorabool River, which will become a mahjor recreational link between the Barwon River and Cowies Creek.

The eastern edge of the quarry will be rehabilitated to a form that will allow it to become part of the lakeside town centre, and to allow public access to the lake.

This report provides information about the Batesford Quarry rehabilitation, hydrology, water quality and the improved conditions that will result to the Moorabool River system. The information draws upon technical reports that have informed quarry operations over the last 20 years (the quarry itself having been operated for some 100 years), and the technical specialists who have provided advice to Adelaide Brighton Ltd and the McCann Group.

Specialist advice is that the characteristics of the quarry and future lake are similar to those successfully dealt with at many quarry sites across Melbourne and overseas, leading to the creation of notable urban and water based recreational developments.

Some of the key points that are noted in the following pages include:

- The quarry rehabilitation works are substantially complete. The most difficult parts of the quarry perimeter have been rehabilitated to safe and stable conditions, to the requirements of Earth Resources Regulation (ERR). By the end of 2018, more than 75% of the perimeter has been rehabilitated.
- The remaining rehabilitation will be progressively implemented as the quarry extraction draws to an end around 2025 (subject to resource life and economic conditions which may alter this date), and will be designed to facilitate integration of the lake edge with the future special lakeside town centre.
- The final lake water level is anticipated to be AHD 9.6m.
- The water level in the lake could be at its final level by 2032.
- The water quality of the lake will be suitable for human contact and for activities including swimming and boating.
- The design and execution of the rehabilitation works would allow flexibility in the design and development of urban development around the future lake.
- There can be a smooth transition during the quarry wind down period to the start of urban development. Development of the urban areas around the future lake and improvements to the Moorabool River corridor could commence prior to the finalisation of quarrying activities and completion of the rehabilitation works.
- The design of the lake water management system would lead to improved ecological values of the Moorabool River and to the maintenance of environmental flows.
- There is opportunity to enhance the environmental values along the Moorabool River corridor by additional planting and the removal of some of the diversion channel linings. This work and controlled public access could commence in the relatively short term.
- An agreement between the quarry operator and Earth Resources Regulation (ERR) provides that the Work Authority over the lake area will be maintained until the lake has been fully recharged. Council can be assured that the Work Authority holder will be fully responsible for maintenance and stability of the perimeter edges until the water level is fully recharged and the quarry lake is ready to hand over to public ownership.

The final working face of the quarry

- Most of the land south of Midland Highway, including all of the quarry area, is owned by Adelaide Brighton Ltd and the McCann Family.
- The diversion channel is within Crown land.

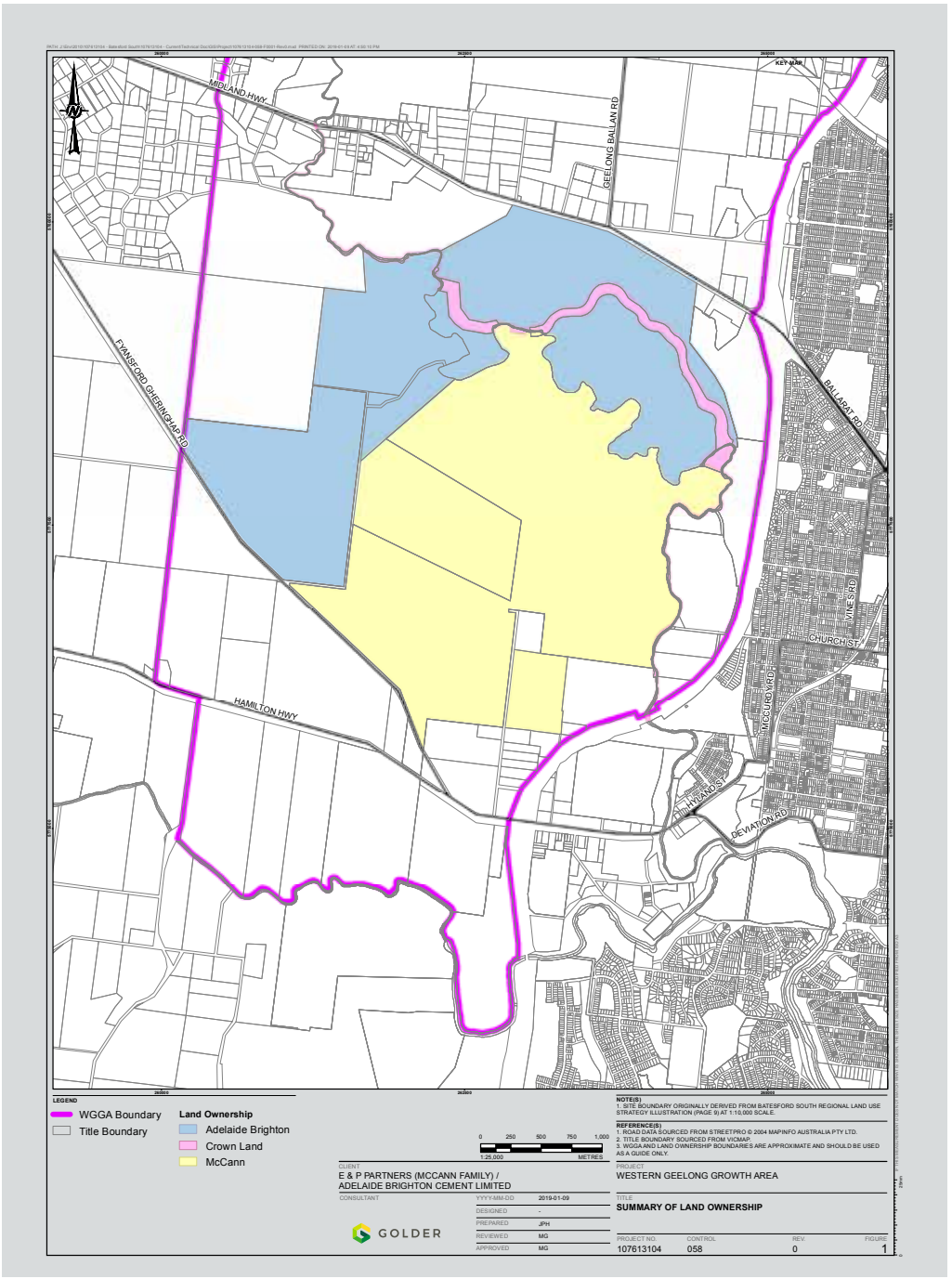



*Figure 1 - Land ownership*

# 2.0 Quarry Rehabilitation

*Figure 2 - 2018*

- *Extent of the rehabilitated quarry face (2018)*
- *Original Moorabool River*
- *Moorabool River Concrete Lined Diversion*

*Figure 3 - 2033*

- *Existing rehabilitation above future water level (completed 2018)*
- *Future rehabilitation for town centre development*
- *Final extraction*
- *Lake*

## Public safety around the edges of the lake

- As of December 2018, 75% of the quarry perimeter has been rehabilitated (*refer to Figure 2)*. The remaining eastern end will be progressively rehabilitated as the final phase of mining winds up. This final rehabilitation will be designed to achieve the lake side edge to the town centre that the Framework Plan proposes for the WGGA (*refer to Figure 3)*.
- Areas designed for public access once the lake has recharged would be established. These areas would be at the eastern edge with gradual slopes (up to perhaps a water depth of 2m). Other areas around the lake would be densely vegetated to restrict public access to the water (key viewpoints could be retained). Vegetation would be established on the batter slopes, the tops of the escarpments and potentially in the shallow water at the lake edges.
- The final extent of the quarry is shown on Figure 3.
- The rehabilitation of the quarry at the eastern edge will be designed to allow access for water based recreational activities.
- The final form of the rehabilitation in this area will be designed, in consultation with the preparation of the Precinct Structure Plan by the City of Greater Geelong, to facilitate development of the special lakeside town centre that is shown on the WGGA Framework Plan.
- It is anticipated that rehabilitation of the eastern edge could be completed in about 2026, assuming that mining were to cease in about 2025.

As of December 2018, 75% of the quarry perimeter has been rehabilitated.

# 3.0 Delivery & Timing

## The quarry rehabilitation plan can be easily amended to create a safe and publicly accessible eastern edge to the lake

### Finalisation of quarry operations will not delay the delivery of the site for residential development

- It is not unusual for rehabilitation plans involving proposals for new after uses to be amended and approved by Earth Resources Regulation.
- The principal changes to the Rehabilitation Plan for the quarry would be to create an area safe for public access to the lake, rather than just to make the sides of the quarry hole safe and stable. The area of opportunity to create safe water access would be at the eastern edge, with potential for active recreation uses, and adjacent to a greenway that would follow the Moorabool River.
- The Work Authority holder will have maintenance responsibility for the quarry hole until 2049, which will cover the period of time for the lake to fully recharge.
- The Rehabilitation Plan would include a Lake Management Plan that would be prepared in consultation with public sector agencies that could have a lake maintenance role in the future. The management plan would be based on an adaptive approach (i.e. continuous refinement of management goals based on knowledge gained) and include a water quality and biological monitoring program to assess the performance of the lake management.
- The existing Rehabilitation Plan would be revised to include the extensive revegetation works proposed between the lake and the diversion, consisting of not only eucalypt species in narrow strips, but a diversity of indigenous robust ground covers, indigenous shrubs and indigenous trees over an extensive area.
- Measures regarding fencing and security around the Work Authority area would be updated to enable public access along trails adjacent to the Moorabool River in the short-term.

North West corner of the Quarry Site looking South East

- The potential "hybrid" proposition for overflows from the Moorabool River to be directed into the lake will be further investigated and possibly incorporated into a revised Rehabilitation Plan.
- There are many examples of the re-use of quarry sites that have been rehabilitated in an urban setting, including:
  - Homebush Bay (Olympic Park), Sydney, which also includes extensive water bodies and water management.
  - Wilson Botanic Park, Berwick (City of Casey) which includes water bodies and quarry faces managed with public safety in mind.
  - Patterson Reserve, Hawthorn (City of Boroondara) developed as sporting grounds, with fenced sheer quarry faces adjacent to two schools.
- At the end of 2018, more than 75% of the quarry perimeter had been rehabilitated.
- Extraction of the remaining limestone reserves is proceeding on the eastern edge of the quarry hole. The quarry operator is finding the ratio of overburden to limestone is becoming unfavourable to ongoing extraction. It is anticipated that commercially viable extraction will be completed around 2025 (subject to resource life and economic conditions).
- The quarry operations affect only a small isolated part of the site. Most of the WGGA could be developed as soon as Precinct Structure Plans have been prepared and would not be affected by final operations at the quarry.

# 4.0 Hydrogeology/Groundwater and Water Quality Of The Proposed Lake

*Figure 4 - Lake filling*

2025

2027 - 45% final depth

2029 - 70% final depth

2031 - 90% final depth

2033 - 100% full
(hybrid filling option)

## The lake recharges following cessation of quarry operations.

***Option 1***

- Modelling of groundwater inflows (Nolan-ITU Groundwater Recovery Investigation 2002) shows that the lake would fill to approximately 75% of final depth within around 7 years of the cessation of dewatering, relying on filling by groundwater change alone. The lake would rise from the existing base level of minus 29m Australian Height Datum (AHD) to approximately zero AHD by this time.
- Complete filling of the lake by groundwater recharge alone would take approximately 15 to 20 years. Following local groundwater recovery, this would fill the lake to a final long-term water level of approximately +9.6m AHD.

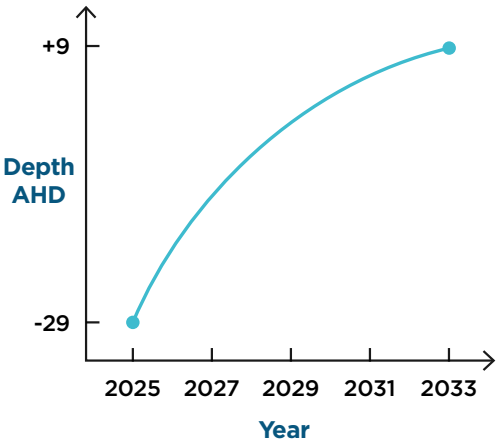
***Option 2***

- Options to accelerate lake filling, include:
  - Engineering the lake catchment to direct more local runoff into the quarry, or
  - Directing a first few years' of peak or seasonal flows from the Moorabool River into the lake

***Option 3***

- A hybrid option of initial filling by groundwater and topping up with peak flows from the Moorabool River could result in the lake being full to final water level within 5 to 8 years of the cessation of dewatering.

*Figure 5 - Hybrid option filling rate*



Example of a recreational Lake Geierswald in a former coal mine pit, Germany.

## The lake's water quality would be appropriate for human contact and potential recreation activities such as swimming, boating, and fishing.

It is understood that CCMA Studies are indicating that the ecological health of the lower Moorabool River and the lower reaches of the Barwon River have benefited from the addition of water from the quarry (which commenced in 2011), to the environmental flows in the Moorabool River. While water quality in the proposed lake is unlikely to be suitable as a potable water source and may not meet typical aquatic ecosystem protection guidelines for ecosystems such as natural lakes and wetlands, it will present an opportunity to establish habitat for a broad range of wildlife. In particular habitat could be developed for water birds and frogs that are commonly encountered in water bodies within Australian urban areas. Careful attention to planning for shoreline habitat could attract a number of endangered aquatic species that require ecological habitat but not necessarily high water quality.

Lessons from pit lakes internationally and also within Australia have shown that recreational opportunities presented by pit lakes often do not require the same high degree of water quality that is required to maintain high conservation values. Many lakes formed in mine pits often face significant water quality challenges caused by acid mine drainage. This lake, with its limestone geologies, will not be faced with these issues.

Water quality is expected to be met for all recreational purposes, including direct contact water quality standards for swimmers and water skiing. Aesthetically, the lake is expected to provide a scenic vista that will attract visitors to the region and enhance the urban environment for locals.

Accordingly, the lake will present an opportunity to be used for a wealth of land-based activities such as picnicking, walking and mountain biking, as well as water-based recreation such as sailing, water skiing and swimming.

Like any lake, water quality will be defined by catchment activities. To this end, catchment planning at an early stage can be directed to achieving water quality consistent with standards appropriate for beneficial end uses identified by the quarry's closure planning for the lake. Rehabilitation options could include redirection of peak flows of the Moorabool River to facilitate more rapid filling of the lake, connection of the lake with other ecological corridors (especially of aquatic habitat), revegetation of some bank sections and stream lines to the lake and the use of wetlands to improve catchment drainage.

Example of a recreational development of a former quarry pit in the Czech Republic.

## It would be practicable to manage the lake as a public recreation reserve

- Mining in broader terms has created thousands of pit lakes internationally, and the Batesford Quarry conditions exceed these examples. Many of these have water quality that is not as good as at the Batesford Quarry, yet still provide recreational opportunities for local and even regional public and tourists.
- Quarry pit lakes generally present opportunities for both human and wildlife use due to their typically good water quality. This will be the case at this quarry lake.
- Internationally, quarry pit lakes have been managed as recreational reserves in a number of European countries and in both Canada and USA (refer to above – former quarry pit in the Czech Republic).
- Depending upon the circumstances, management authority may be vested in local government or a government agency. Alternatively a combined approach- as at Lillydale Lake in Melbourne – jointly managed by Melbourne Water and the Shire of Yarra Ranges could be considered. Typically a site such as the Batesford Quarry lake would be managed as parkland for both its public and ecological values.


Moorabool River

# 5.0 Hydrology/Surface Water of the Moorabool

## Cessation of quarry dewatering activities will improve the flows of the Moorabool River.

- The flows in the Moorabool River diversion would be likely to improve following cessation of quarry dewatering at the end of the quarry life. As soon as the lake starts to fill, groundwater levels in the immediate vicinity would begin to recover. This recovery would be quite rapid in the first few years and would then slow to a more gradual process until the cone of depression disappears. This will occur when the lake water level is established (estimated to be at +9.6 m AHD), close to the river invert levels. This recovery of groundwater levels would remove the current persistent leakage from an earlier river diversion into the quarry void and would result in a more natural flow regime in the Moorabool River diversion (refer to illustrations A and B).
- Cessation of dewatering would improve downstream river flow volumes and also would be likely to improve river water quality. Overall the base flows in the Moorabool River would increase and would return to their natural seasonal pattern.

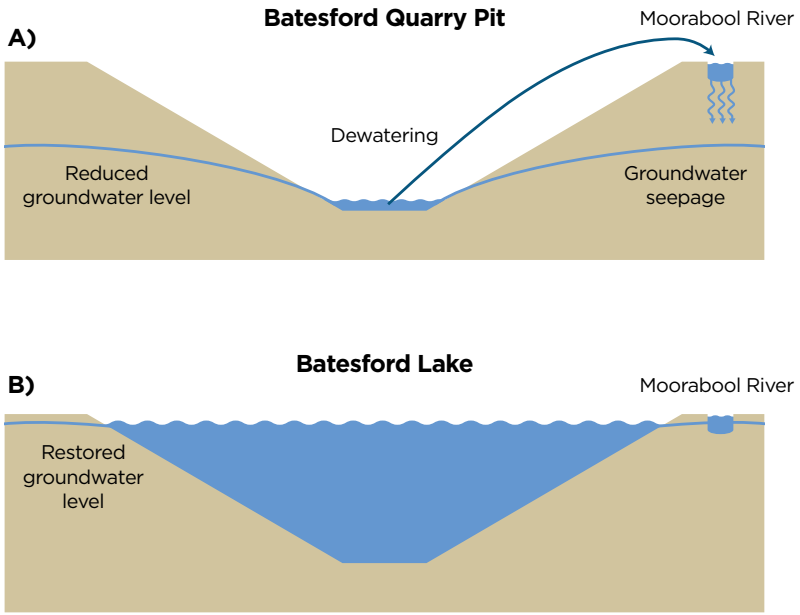



*Figure 6 - Groundwater recovery*

## Integration of Moorabool River flows and the proposed lake

- It would not be advisable to redirect all of the river flow through the lake. This would adversely affect water quality, including nutrient loads in the lake as well as reducing the natural flow of sediments and nutrients to the lower Moorabool River and Barwon River.
- The Quarry Rehabilitation Plan (2005) plans to fill the quarry and keep the Moorabool River diversion separate in terms of surface water connections.
- There is an opportunity to integrate the river and the lake in a hybrid river flow option that provides for redirection of peak flows into the quarry during periods of seasonal peak flows and floods, as discussed below. This option is now the preferred approach.
- The hybrid river option would allow some peak flows to be directed from the Moorabool River into the lake, with outflow via the old river course. This could have a number of advantages, including:
  - Speeding up the filling of the lake, especially after a few years of initial filling from groundwater.
  - Periodic freshening up the water in the lake by reducing salinity levels that would result from filling the lake by groundwater alone.
  - Continuation of low flows in the Moorabool River diversion with improved base flows, ecological conditions and sediment flows through the diversion.
  - Diverting medium sized “spring” peak flows into the lake (perhaps a few times per year) to mitigate moderate floods as well as freshening the lake water.
  - Increasing the frequency of turnover of water in the lake to reduce the possibility of stratification and/or algal blooms.
  - Having an overflow from the lake for regular, but intermittent flows into the old course of the Moorabool River, adjacent to the proposed lakeside town centre, immediately downstream of the lake to improve the environmental values of this reach of the old river.
  - Allowing large floods to be split between the lake and the river diversion.

*Peak Flows*

*Normal Flows*

Old 1930's river diversion

## Improvements to the physical and environmental conditions of the Moorabool River, in particular the diversion

- There are a number of practicable measures that could be taken to improve the physical and environmental values of the Moorabool River diversion:
  - Breaking up the concrete invert and additional bank planting downstream of the last of the three habitat pools. Hydraulic modelling and valley cross sections show that this can occur without significant increase in erosion risk.
  - Placement of rock beaching in the concrete invert for the upstream reaches of the concrete channel where the velocities are too high to completely remove the concrete and/or the gabion erosion protection blocks.
  - With the hybrid river flow option, the gabions currently used for erosion protection could be removed and replaced with vegetation, particularly between the existing habitat pools. Planting would provide habitat and shade to the waterway and provide some improvement of conditions for fish passage for the entire length of the diversion.

# 6.0 Terrestrial Ecology

Stonehaven Redgum

## Improvements to the terrestrial ecology of the WGGA

- The WGGA has the potential to significantly improve the terrestrial ecology of the site, as extensive revegetation works are proposed between the lake and the Moorabool River diversion. Planting, consisting of not only narrow strips of eucalypt species, but also a diversity of indigenous robust ground covers, shrubs and trees over an extensive area would provide a significant boost to the available fauna habitat. The site would become not only a movement corridor between two significant remnants (Barwon River corridor and Dogs Rocks), but also a substantial area of significant habitat, per se.
- The WGGA proposal for the lake surrounds aims to revegetate the edges with both aquatic and semi-aquatic species to provide significant habitat diversity for amphibians, mammals, birds and reptiles. Fringing terrestrial vegetation consisting of a variety of life forms (shrubs and trees) and indigenous species along the edges of the lake would provide further habitat for raptors and other birds.
- There is the further potential, with development, to raise the river water levels in the old Moorabool River and return the water course to a more natural hydrological regime, presenting an opportunity to rehabilitate the remnant riparian vegetation and revegetate the corridor with River Red Gums, and retaining the stags.

Moorabool River below the Quarry

# 7.0 Aquatic Ecology

## The proposal would improve the aquatic ecology of the area

- The WGGA proposal would improve the aquatic ecology of the lake by providing a diversity of fauna habitats along the diversion, including deeper pools, riffle sections and slowing the speed of the water during flood events. The aquatic ecology and diversity would be enhanced by the addition of snags in the deeper pools, and the planting of overhanging and robust indigenous ground covers and shrubs. Rehabilitation of the old Moorabool River course would increase the diversity of aquatic habitats and provide significant habitat for a diversity of amphibians, mammals, birds and reptiles.

- It is proposed to improve the aquatic ecology of the lake by flushing during high flows. This will assist to enhance the diversity of habitats within the lake, making it more suitable for fish stocking and for other aquatic species.

- There would be numerous benefits from implementing the lake proposal:

1. Revegetation could be started immediately, whereas typically, revegetation is undertaken towards the end of the quarry's life. A first priority would be to open up a link trail along the Moorabool River (see the Greenways section 8.0) to connect to the Fyansford Green and Barwon River network. Phasing in recreational access prior to the end of quarry operations would facilitate an overlap of land use that would allow trail grading and planting to be completed and established well before recreational patterns of use become entrenched. Recreational open spaces are frequently 'rushed into service' without the benefit of a season or two to allow planting to stabilise. This fallow period is particularly beneficial for restoration landscapes using native species.

2. A great diversity of life forms is proposed, including robust and indigenous ground covers, shrubs and trees.

3. The larger area of land to be revegetated would become a significant fauna habitat area.

4. The larger area of land to be revegetated would become a significant connection/ corridor between the Barwon River corridor and Dogs Rocks Flora and Fauna Sanctuary.

5. The lake could be flushed during high flows, restoring the old Moorabool River course to a more natural hydrological regime. Both the lake and the old Moorabool River course would provide enhanced fauna habitats.

6. The aquatic ecology of the Moorabool River diversion would be improved by altering the flows and habitats along its length, such as introducing large logs and riffle sections, and low-overhanging vegetation.

# 8.0 Moorabool River Greenway

## The proposed Moorabool River Greenway would link with the existing trail network

- Trail network extensions are envisaged within the City of Greater Geelong Study of Open Space Networks (Tract & Leisure Planning, 2001). This study envisages a major green link along the Moorabool River.
- These values were subsequently reinforced within the G21 Pillar: G21 Regional Trails Network which provides guidance on recommended trail enhancement projects and priorities for investment.
- Extensions to the recreational trail network are referenced in the Greater Geelong Cycle Strategy (2008) indicating the transportation benefits of a trail network developed to provide commuting alternatives.
- Sketch assessments of trail alignment options indicate that recreational and habitat greenway connections may be established to correspond with the alignments of the Moorabool River, Barwon River, and Cowies Creek watercourses.
- Direct links to the existing Geelong trail network have been confirmed in the development planning for Fyansford Green site. With these links in place Geelong would have the opportunity to develop a broad expansion of its trail network designed to skirt the active quarry operations and with the potential to link to the Dog Rocks outcrop.
- The lake would facilitate development of the proposed Moorabool River Greenway. This would provide an unprecedented opportunity to create a recreational “loop” joining existing trails along Barwon River and Cowies Creek via the Moorabool River for residents from all over Geelong to enjoy.

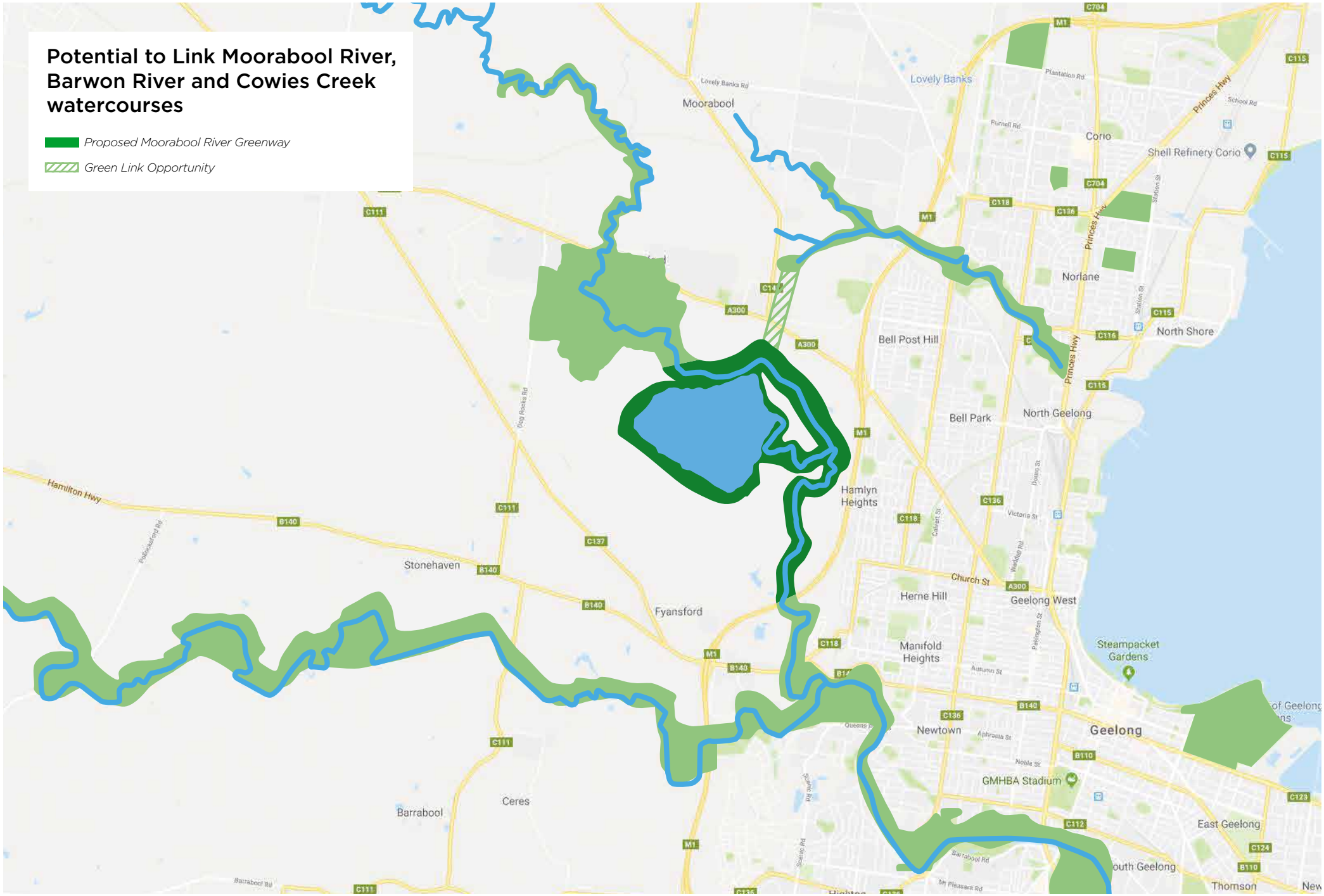



*Figure 7 - Moorabool River Greenway concept*

## The proposed Moorabool River Greenway would benefit neighbouring communities and Geelong

- The adaptive reuse of the Batesford Quarry site as a lake would provide a unique and outstanding recreational amenity for the residents of Geelong. Beyond the direct recreational benefits of extending the city's trail network, the aesthetic and recreational benefits of the lake cannot be overstated. Given its scale (more than a kilometre across) and location (six kilometres from the Geelong CBD) this lake can be expected to become a significant regional recreational landmark.
- Supporting infrastructure developed in addition to the lake may provide for enhanced recreational tourism, for example: facilities may be provided for rowing, dinghy sailing, sail boarding, paddling that allow for occasional use, and competition. Commercial facilities may be developed to support these uses including: coffee, food, equipment rental, meeting facilities, boat houses, etc.
- Preliminary investigations of trail alignments through the WGGA indicate a variety of opportunities to create looped network connections that will be significant in providing flexibility of use and access for existing, and future proposed Geelong residents.
- International experience in the design of communities with a compact urban form strongly correlates their success to the availability of a substantial and linked open space network. The varied topography of the WGGA would allow for the development of a range of housing types. More affordable housing options, such as apartments and/or homes built on small sections, will be more successful if complementary infrastructure is provided, such as the proposed Moorabool River Greenway.

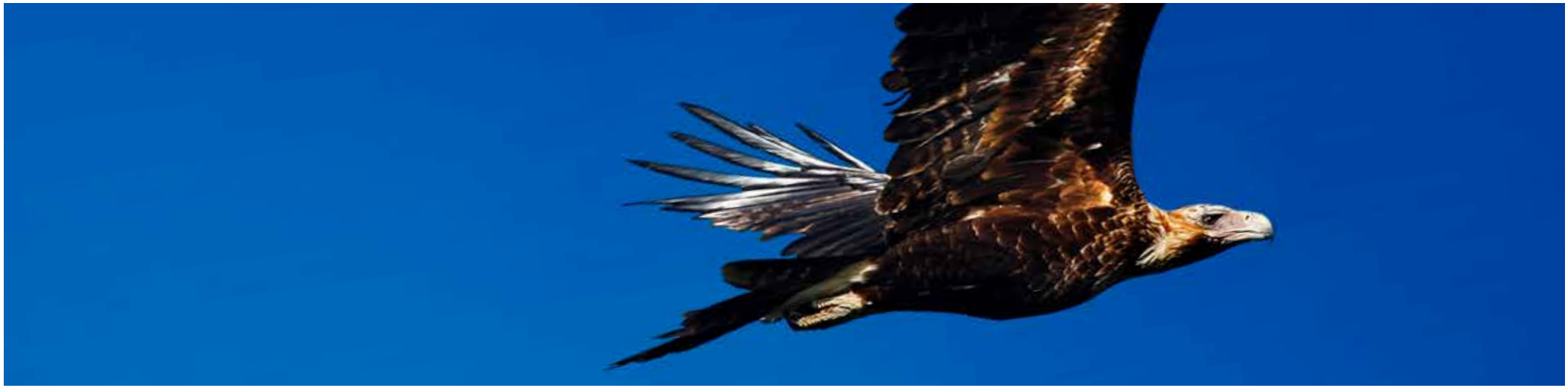
## Management of the Moorabool River Greenway and open space

- It is envisaged that the Moorabool River Greenway and the lake would become a public asset. Due to its size, it is anticipated that the lake would be maintained by Parks Victoria, possibly in partnership with Council.
- Examples of maintenance arrangements for artificial water bodies in urban settings in Victoria include:
  - Lilydale Lake, Lilydale – approximately 31ha surface area; artificially created for storm water management; trails around; boating and fishing. Jointly managed by Yarra Ranges Council and Melbourne Water.
  - Niddrie Lake, Niddrie – approximately 3ha surface area; on the site of a former quarry; trails around; developed by Places Victoria as part of a residential masterplan for Valley Lakes. Places Victoria maintains the open space (including the lake) until completion of the scheme, at which stage it will be handed over to Niddrie Council.
  - Karkarook Park, Heatherton – approximately 21ha surface area; on the site of a former quarry; trails around; fishing. Managed by Parks Victoria.
  - Edgewater Lake, Maribyrnong– approximately 10ha surface area; trails around; boating; fishing; developed as part of a residential masterplan for Edgewater on Maribyrnong. Managed by Parks Victoria.
  - Examples of larger, established lake/park developments with public access include Maroondah Lake, Lake Eildon (Parks Victoria)Lake Wendouree (City of Ballarat) and Lake Eppalock (Goulburn Murray Water).
- An Environmental Management Plan may be developed with a (revised) Rehabilitation Plan for the Batesford Quarry. This could include a number of management actions and contingencies that could be handed over to public ownership to provide a head start in understanding ongoing maintenance obligations.
- Adelaide Brighton Ltd is responsible for maintaining the 1980's Moorabool River diversion with the agreement of Southern Rural Water. The Crown also owns parts of the diversion (refer Figure 1). Both Southern Rural Water and the Crown would need to be involved in discussions about proposed works designed to improve the ecological and recreational values of the diversion.
- Council would be a referral authority for the Department of Primary Industries when the Batesford Quarry Rehabilitation Plan is updated to reflect the change in the post-operations land use (residential rather than agricultural). Council therefore will have an opportunity to ensure that the Rehabilitation Plan associated with the Work Plan is revised in line with its expectations for the site.

## The Moorabool River Greenway will be brought forward for the community to use

- The current Work Plan for Batesford Quarry indicates that extraction may continue to around 2025 (subject to resource life and economic conditions). Rehabilitation on terminal faces was 75% complete at the end of 2018.
- The proposed Moorabool River Greenway could be implemented in stages. Parts of the Greenway could be made available for public access before completion of quarry operations, and before the lake reaches its final level.
- Rehabilitation at the eastern edge of the lake would provide profiles for areas of safe water access. Revegetation is likely to incorporate opportunities for barrier planting and the creation and framing of iconic viewpoints.
- Once the connection through the 'Fyansford Green' site is in place the completion of a Greenway link following the Moorabool River and the diversion channel can be developed generally following the existing grade.


*Figure 8 - The Fyansford Green area will be developed, opening up access to the site from the Barwon River network.*



## The risks to public safety, for people using the Moorabool River Greenway, from ongoing quarry operations are minimal

- Risk associated with the creation of a greenway trail adjacent to the Batesford Quarry are low and can be managed through the use of standard best practice for recreational trails.
- Trail development would include a continuous separation fence ensuring that accidental access to active industrial areas is eliminated.
- Separate fencing could include frequent informational signage indicating the presence of an active industrial activity.
- Trail layout could take advantage of occasional viewpoints to allow recreational users to observe final quarry operations and the lake as it fills. Viewpoints could incorporate interpretive signage that describes and educates people about current and past industrial activity and the industrial heritage.
- Trail development would consider vehicle access points to provide access in the case of emergency (fire); security access to respond to negative activity (vandalism, etc); and general maintenance. This could be provided via the existing low grade road from Church Street to the east, and via existing access from the Midland Highway to the north.
- The safeguards provided above can reasonably be expected to provide a safe recreational experience for site users.

## There are few physical constraints to delivering the Moorabool River Greenway

- An assessment of the current site conditions has identified very few significant constraints to the development of a fully formed Greenway trail alongside the Moorabool River waterway.
- The existing topography along the watercourses lends itself to the development of an accessible trail network with significant potential as a transportation alternative to vehicle travel between the WGGA and central Geelong (for pedestrians, runners, cyclists).

# References and Acknowledgements

## References


Moorabool River Basin Local Management Plan (May 2014)

The Living Moorabool Restoration Project (2017)

Nolan-ITU Groundwater Recovery Investigation (2002)

Nolan-ITU Groundwater Quality Study (2005)

City of Greater Geelong Study of Open Space Networks (Tract & Leisure Planning) 2001

Greater Geelong Cycle Strategy (2008)


## Specialists

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