



# Impact Management Plan

## *Macadamia integrifolia* (Macadamia Nut)

Blue Rock Quarry  
Tamaree Road, Cedar Creek, QLD 4207  
Prepared for Fulton Hogan Quarries Pty Ltd

11 March 2026

**Saunders  
Havill**

PATHWAYS TO SUCCESS

# Document Control

Document: Impact Management Plan (*Macadamia integrifolia*) for Blue Rock Quarry, Tamaree Road, Cedar Creek, QLD 4207, prepared by Saunders Havill Group for Fulton Hogan Quarries Pty Ltd.

## Document Issue

Issue	Date	Prepared By	Checked By
A	25.11.2025	NT	LB
B	11.03.2026	LB	SM

Prepared by

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# Acronyms and Abbreviations

DCCEEW	Department of Climate Change, Energy, the Environment and Water (Cth)
DETSI	Department of Environment, Tourism, Science and Innovation (Queensland [Qld]) (formerly Department of Environment and Science)
EPBC	<i>Environment Protection and Biodiversity Conservation Act 1999</i> (Commonwealth [Cth])
CEEVNT	Critically Endangered, Endangered, Vulnerable and Near Threatened (as listed in the <i>Nature Conservation [Plants] Regulation 2020</i> )
MSES	Matters of State Environmental Significance
NCA	<i>Nature Conservation Act 1992</i> (Qld)
NCPR	<i>Nature Conservation (Plants) Regulation 2020</i> (Qld)
PMAV	Property Map of Assessable Vegetation
SH	Saunders Havill
SRI	Significant Residual Impact
VMA	<i>Vegetation Management Act 1999</i> (Qld)

<b>Expansion Area</b>	Refers to the 5.9 ha direct clearing area
<b>Clearing Impact Area</b>	Refers to the 5.9 ha direct clearing area and 100m buffer
<b>POA</b>	Refers to the Planting Offset Area where the <i>Macadamia integrifolia</i> will be offset



# 1. Introduction

**Saunders Havill (SH)** was engaged by **Fulton Hogan Quarries Pty Ltd** to complete a flora survey for the Blue Rock Quarry expansion area. The quarry expansion area is located within a mapped 'High Risk' area under the *Nature Conservation Act 1992 (NCA)* which indicated there may be flora protected under the *Nature Conservation (Plants) Regulation 2020 (NCPR)* present at this location and triggered the need for a flora survey and report as per the protected plant survey guidelines.

The expansion area is in the southern extent of the existing Blue Rock Quarry, Cedar Creek. The quarry is accessed from near the intersection of Tamaree Road and Beaudesert Beenleigh Road and is located approximately 9 km north from Tamborine Village or 12 km from the M1 Highway near Yatala. Blue Rock Quarry has been in operation since the 1970's and is surrounded by a combination of remnant and regrowth vegetation with a mixture of rural land uses and retained vegetation. Refer to **Figure 1** for site context and **Figure 2** for site aerial. The protected plants 'high risk' area Flora Survey Trigger Map across the Blue Rock Quarry site, is generally aligned with existing vegetation including Category B (remnant), Category C (high-value regrowth) and Category X (non-remnant ) vegetation (refer **Figure 3**). Key site details are provided in **Table 1**.

Under the NCA, the 'clearing impact area' includes both the area to be cleared and 100 m buffer area. During protected plant surveys of the clearing impact area and associated buffer, specimens of *Macadamia integrifolia* (Macadamia Nut) were recorded within the eastern extent of the clearing impact area. *Macadamia integrifolia* specimens recorded are considered a threatened plant under the NCA. As they meet the classification of "in the wild", the presence of these specimens within the clearing impact area triggers the requirement for an Impact Management Plan (IMP).

This IMP is intended to support a *Clearing Permit (Protected Plants)* application to support a protected plants clearing application to Department of Environment, Tourism, Science and Innovation (DETSI) to request clearing to occur where known NCA threatened plants are present within the clearing impact area. This IMP has been prepared in accordance with **Section 3.2** of the *Nature Conservation (Plants) Regulation 2020 – Protected Plants Assessment Guidelines*.

*An impact management plan must include the following sections:*

- *attempts to avoid and minimise impact;*
- *nature of impact;*
- *management of impact;*
- *justification of impact management; and*
- *survival of plant in the wild.*

Specific management and mitigations measures are included in this IMP which will be implemented prior to and during quarry operations to mitigate and/or minimise the potential impacts on *Macadamia integrifolia* specimens within and adjacent to the expansion area.



*Macadamia integrifolia* is listed as 'vulnerable' under both the state NCA 1992 and the federal EPBC Act 1999. Therefore, this IMP has been developed to satisfy management and offset requirements of the future state approval and current federal approval process (EPBC 2024-09844).

**Table 1: Property summary**

<b>Address</b>	Blue Rock Quarry, Tamaree Road, Cedar Creek, Queensland
<b>RPD</b>	Part of Lot 89 on WD739
<b>LGA</b>	City of Gold Coast
<b>Planning Scheme / Local Plan</b>	City Plan Version 10 (Commenced 4 <sup>th</sup> July, 2023)
<b>Existing Land Use</b>	Extraction Industry (Blue Rock Quarry)
<b>Direct Impact Area</b>	5.9 ha
<b>NCA Clearing Impact Area (CIA) – inclusive of 100m buffer</b>	12.5 ha

## 1.1. Nature Conservation Act 1992

The NCA classifies and protects significant areas (protected areas) and protects threatened plant and animal species. The *Nature Conservation (Plants) Regulation 2020* (NCPR) lists plant and animal species presumed extinct, endangered, vulnerable, near threatened, least concern, international or prohibited. The schedules of this regulation were considered in this IMP using DETSI's Wildlife Online database search for a 5 km radius of the site.

Flora species listed under the NCPR with the potential to occur around the subject site are shown in **Table 2**. The complete results of this search are included **Appendix A**.

Vegetation surrounding the current quarry footprint is within the 'High Risk' Area of the Protected Plants Flora Survey Trigger Map (refer **Figure 3**).

**Table 2: NCA Wildlife Online Search Results (flora)**

<b>Scientific Name</b>	<b>Common Name</b>	<b>NCA Status</b>
<i>Leichhardtia coronata</i>		Vulnerable
<i>Pararistolochia praevenosa</i>		Near Threatened
<i>Picris conyzoides</i>		Vulnerable
<i>Corynocarpus rupestris</i> subsp. <i>arborescens</i>	Southern Corynocarpus	Vulnerable
<i>Styphelia recurvisepala</i>		Endangered
<i>Baloghia marmorata</i>	Jointed Baloghia	Vulnerable
<i>Fontainea venosa</i>		Vulnerable
<i>Coleus habrophyllus</i>		Endangered

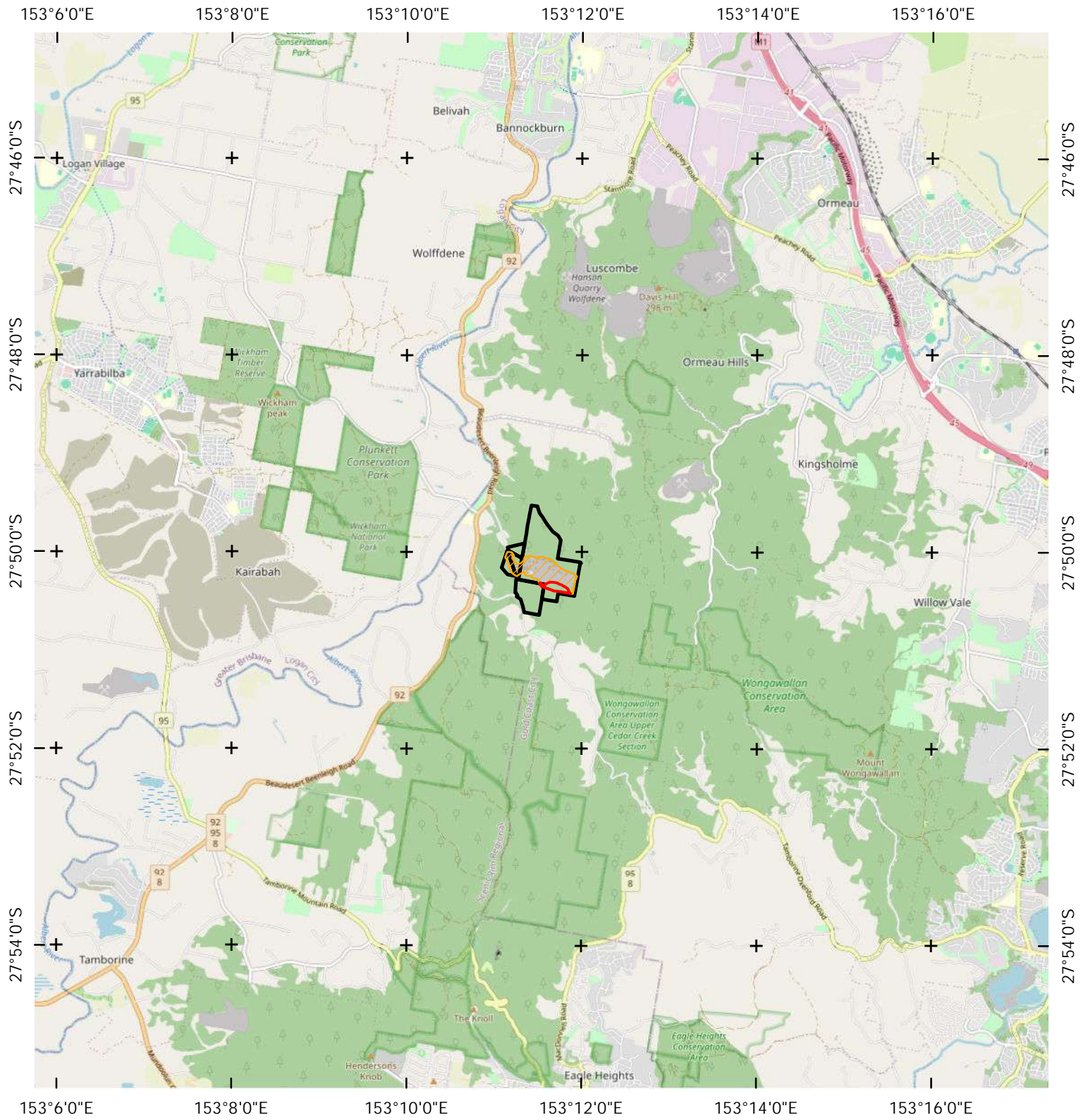


<b>Scientific Name</b>	<b>Common Name</b>	<b>NCA Status</b>
<i>Cryptocarya foetida</i>	Stinking Cryptocarya	Vulnerable
<i>Endiandra wongawallanensis</i>		Endangered
<i>Sophora fraseri</i>	Brush Sophora	Vulnerable
<i>Eucalyptus curtisii</i>	Plunkett Mallee	Near Threatened
<i>Gossia gonoclada</i>		Critically Endangered
<i>Gossia hillii</i>		Critically Endangered
<i>Melaleuca irbyana</i>		Endangered
<i>Rhodamnia dumicola</i>	Rib-fruited Malletwood	Endangered
<i>Rhodamnia rubescens</i>	Scrub Turpentine	Critically Endangered
<i>Rhodomyrtus psidioides</i>	Native Guava	Critically Endangered
<i>Jasminum jenniae</i>		Endnagered
<i>Macadamia integrifolia</i>	Macadamia Nut	Vulnerable
<i>Macadamia tetraphylla</i>		Vulnerable
<i>Randia moorei</i>	Spiny Gardenia	Endangered
<i>Cupaniopsis newmanii</i>	Long-leaved Tuckeroo	Near Threatened
<i>Planchonella eerwah</i>		Endangered
<i>Corchorus cunninghamii</i>		Endangered
<i>Brachychiton sp. (Ormeau)</i>	Ormeau Bottle Tree	Critically Endangered







**Figure 1: Site context**





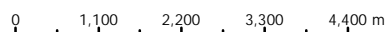
**LEGEND**

-  Site Boundary
-  Referral Area [5.9 ha]
-  Quarry Expansion Area
-  Existing Quarry Area

**FIGURE A1**

**SITE CONTEXT**

PROJECT  
CEDAR CREEK, QLD  
COORDINATE SYSTEM  
GDA 2020 MGA Z56  
SCALE (A4)  
1:100,000



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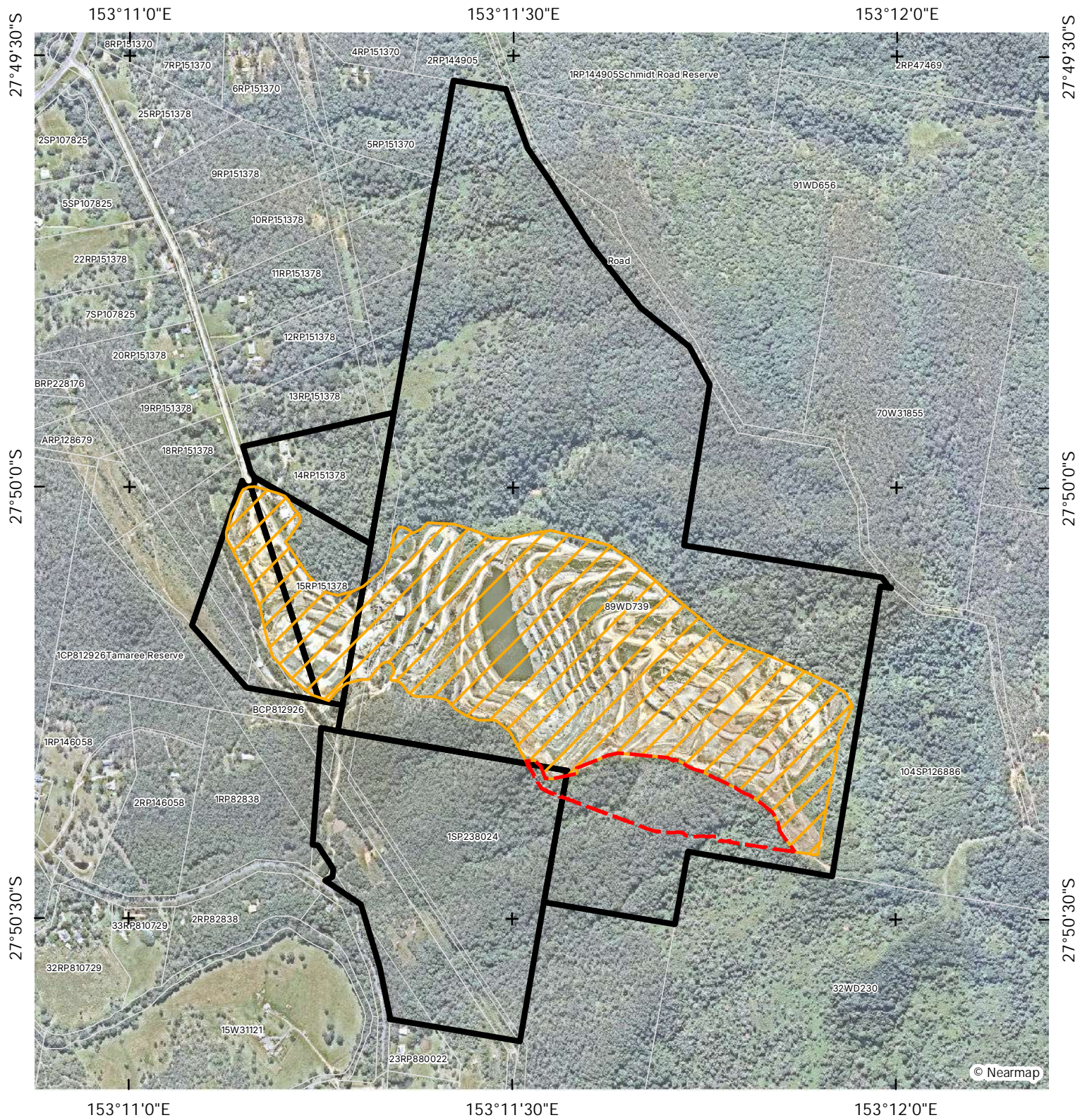
**LAYER SOURCE**

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**FILE REFERENCE**

11390 E MIMP Figure 1 Site Context A

DATE 7/10/2025



**LEGEND**

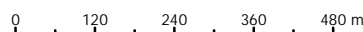
- Qld DCDB
- Site Boundary
- Referral Area [5.9 ha]  
*Quarry Expansion Area*
- Existing Quarry Area

**FIGURE A2**

SITE AERIAL

PROJECT  
CEDAR CREEK, QLD  
COORDINATE SYSTEM  
GDA 2020 MGA Z56

SCALE (A4)  
1:11,419



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**FILE REFERENCE**

11390 E MIMP Figure 2 Site Aerial A

DATE 7/10/2025

153°11'30"E

153°11'45"E

27°50'15"S

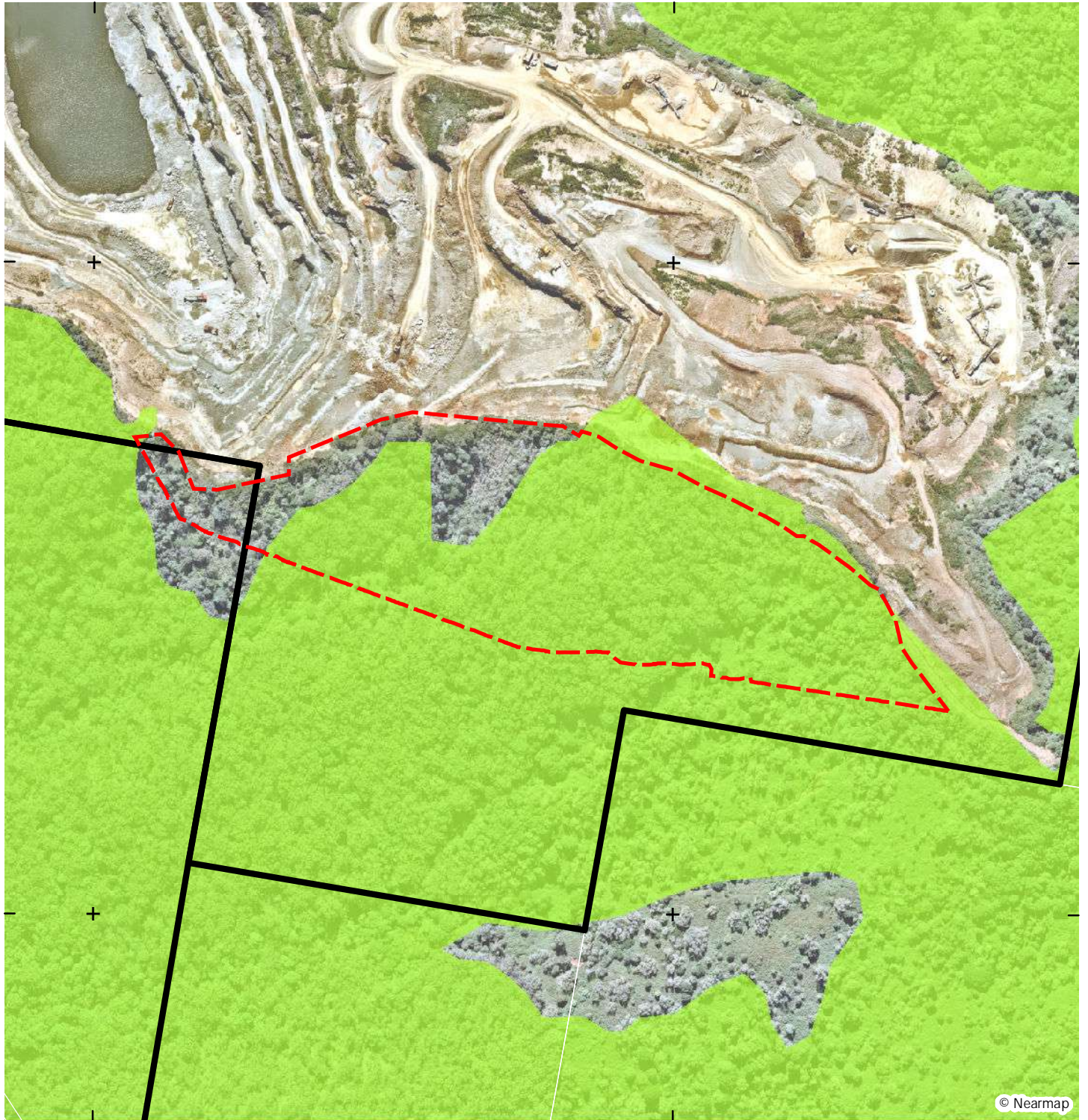
27°50'15"S

27°50'30"S

27°50'30"S

153°11'30"E

153°11'45"E



LEGEND

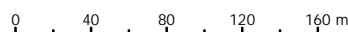
- Qld DCDB
- Site Boundary
- Referral Area [5.9 ha]
- Quarry Expansion Area
- NCA Protected Plants
- High risk area - flora survey trigger

FIGURE A3

NCA PROTECTED PLANTS MAPPING

PROJECT  
CEDAR CREEK, QLD  
COORDINATE SYSTEM  
GDA 2020 MGA Z56

SCALE (A4)  
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11390 E MIMP Figure 3 NCA A

DATE 7/10/2025

## 2. Nature of Impact

### 2.1. Background

Blue Rock Quarry has been in operation since the 1970's, with the internal quarry footprint being cleared and maintained continuously through to the present day. The quarry expansion area associated with this report is a 5.9 ha area located south of the existing quarry footprint. The expansion area is partially mapped under a Property Map of Assessable Vegetation (PMAV), which contains Category X (non-remnant) vegetation and Category B (remnant) vegetation described as 'Least Concern' RE 12.11.3 (refer **Figure 4**). Areas of Category X (non-remnant) within the quarry expansion area reflect regrowth areas of 'Least Concern' RE 12.11.3 and 'Least Concern' RE12.11.10, however have not been mapped as Category C (high-value regrowth) due to the presence of a PMAV.

Presently vegetation extends to the south of the expansion area whilst the north is completely cleared to facilitate current quarry operations. Protected Plants Flora Survey Trigger Mapping (High Risk Area) is mapped across most of the expansion area, also extending south-west, south and south-east outside of the quarry expansion area. As a result of high-risk mapping being present within the clearing impact area, a flora survey in accordance with the methodology described in the *Flora Survey Guidelines – Protected Plants 2020* was undertaken.

The results of field survey identified seventeen (17) *Macadamia integrifolia* (Macadamia Nut) individuals (including juvenile and semi-mature specimens) within the protected plant survey area. Fifteen (15) of these specimens are proposed to be directly impacted and two (2) specimens are proposed to be retained within 100 m of the expansion area (refer **Plan 1** for locations and **Plan 2** for impact assessment). *Macadamia integrifolia* (Macadamia Nut) were the only Critically Endangered, Endangered, Vulnerable or Near Threatened (CEEVNT) protected plant found within the clearing impact area. The species profile for *Macadamia integrifolia* is detailed in **Section 2.2**. Further details of the *Macadamia integrifolia* (Macadamia Nut) specimens recorded on-site are provided in **Section 2.3**.

### 2.2. Protected plant profile

*Macadamia integrifolia* (Macadamia Nut) is a member of the Proteaceae family and listed as a Vulnerable threatened species under Schedule 2 of the NCP. *Macadamia integrifolia* naturally occur within the northeast New South Wales-southeast Queensland coastal region. Within their distribution range, *Macadamia integrifolia* are endemic to rainforest and wet sclerophyll forest communities, including notophyll vine forest. The Queensland Herbarium Regional Ecosystem Description Database identifies *Macadamia integrifolia* as occurring in association with Regional Ecosystems (REs) 12.3.1, 12.8.3, 12.11.10 and 12.12.16. In addition, this species is genetically closely related to and often hybridises with *Macadamia tetraphylla* (Rough-Shelled Nut).

*Macadamia integrifolia* (Macadamia nut) is a long-lived perennial evergreen mid-storey subtropical rainforest tree to 20 m tall. Individuals are often multi stemmed with small crowns, with greyish branchlets dotted with raised lenticels. The simple obovate to narrowly oblong leaves are arranged in whorls of three or opposite and are generally 5.5 cm to 14 cm long by 2.5 cm to 6 cm wide. Blade tips are rounded and finish in a short sharp point; the base tapers to petioles 5 to 10 mm long. Axillary creamy-white flowers are arranged in brush-like hanging racemes 10 to 30 cm long.



### 2.3. *Macadamia integrifolia* site description

The Blue Rock Quarry clearing impact area includes three distinct mapped vegetation communities, however the majority is mapped as either remnant or non-remnant RE 12.11.3 (Eucalypt Woodland). The eastern and south-eastern extent of the clearing impact area is mapped as non-remnant vegetation containing regrowth RE 12.11.10 (notophyll vine forest) and RE 12.11.3 (Eucalypt Open Forest) (refer **Figure 4** and **Table 3**). Of the regional ecosystems mapped within Blue Rock Quarry, only RE 12.11.10 is recognised as containing potentially suitable habitat for *Macadamia integrifolia*. Notably, *Macadamia integrifolia* specimens recorded during surveys were only observed within the parts of the clearing impact area which reflect RE 12.11.10.

**Table 3: Regional Ecosystem Vegetation Descriptions**

Regional Ecosystem	VMA Status	Description
RE 12.11.3	Least Concern	<i>Eucalyptus siderophloia</i> and <i>E. propinqua</i> open forest +/- <i>E. microcorys</i> , <i>Lophostemon confertus</i> , <i>Corymbia intermedia</i> , <i>E. biturbinata</i> , <i>E. acmenoides</i> , <i>E. tereticornis</i> , <i>E. moluccana</i> , <i>Angophora leiocarpa</i> , <i>Syncarpia verecunda</i> with vine forest species and <i>E. grandis</i> or <i>E. saligna</i> in gullies. <i>Eucalyptus pilularis</i> and <i>E. tindaliae</i> sometimes present e.g. mid D'Aguilar Range, Conondale Range. Occurs predominantly on hills and ranges of Palaeozoic and older moderately to strongly deformed and metamorphosed sediments and interbedded volcanics. Not a Wetland. (BVG1M: 9a)
RE 12.11.10	Least Concern	Notophyll and notophyll/microphyll vine forest +/- <i>Araucaria cunninghamii</i> . Characteristic species include <i>Argyrodendron trifoliolatum</i> , <i>Argyrodendron</i> sp. (Kin Kin W.D.Francis AQ81198), <i>Backhousia subargentea</i> , <i>Dissiliaria baloghoides</i> , <i>Brachychiton discolor</i> , <i>Beilschmiedia obtusifolia</i> , <i>Diospyros pentamera</i> , <i>Grevillea robusta</i> , <i>Gmelina leichhardtii</i> and <i>Ficus macrophylla</i> forma <i>macrophylla</i> . Occurs on Palaeozoic and older moderately to strongly deformed and metamorphosed sediments and interbedded volcanics. Not a Wetland. (BVG1M: 2a).



153°11'0"E

153°11'30"E

153°12'0"E

27°49'30"S

27°49'30"S

27°50'0"S

27°50'0"S

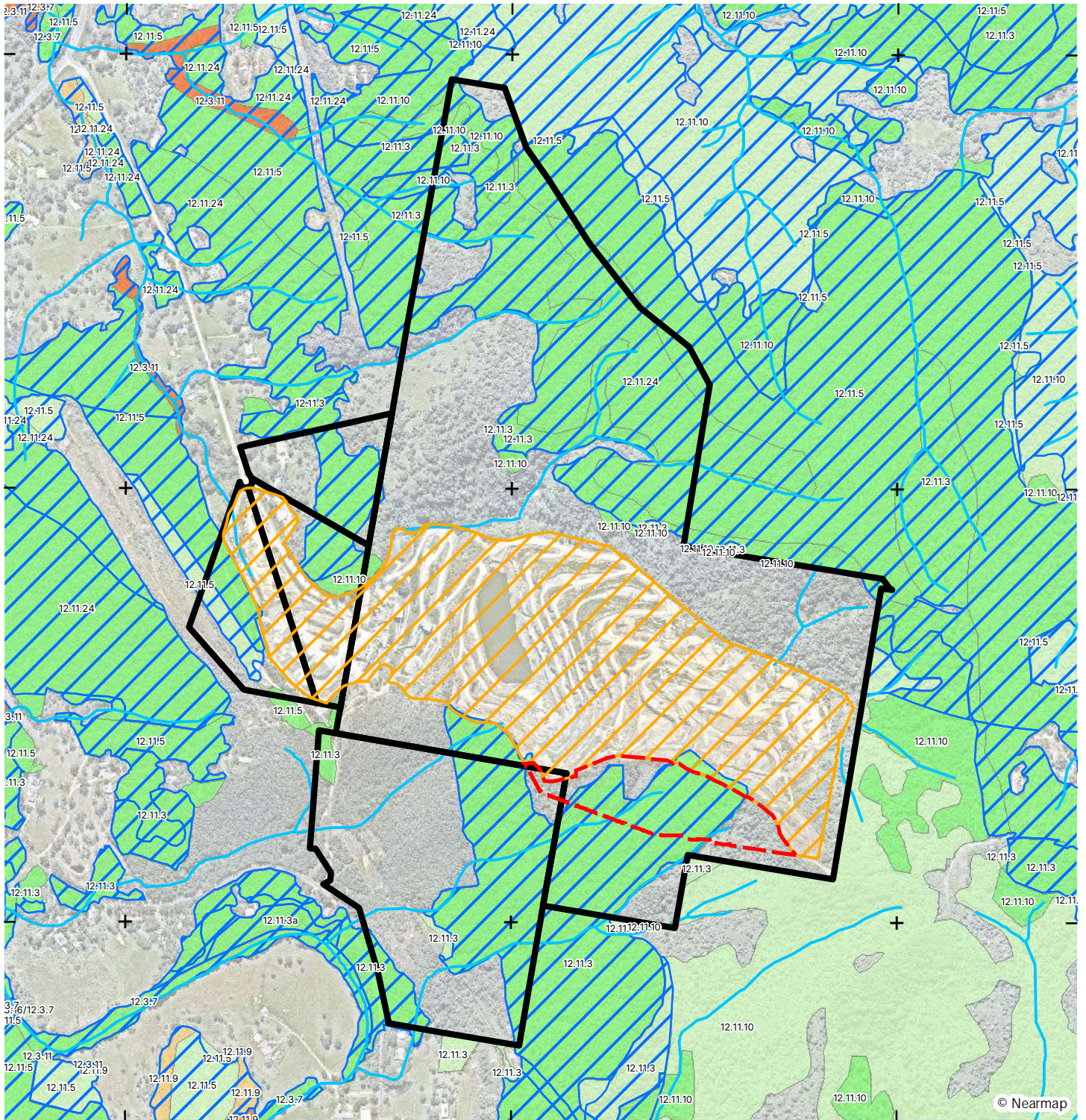
27°50'30"S

27°50'30"S

153°11'0"E

153°11'30"E

153°12'0"E



LEGEND

- Site Boundary
- Referral Area [5.9 ha] Quarry Expansion Area
- Existing Quarry Area
- VM Watercourses
- VM Essential Habitat
- VMRE Mapping**
- Category A or B area containing of concern regional ecosystems
- Category C area containing of concern regional ecosystems
- Category C area that is a least concern regional ecosystem

FIGURE A4

SUPPORTING VEGETATION MAP

PROJECT  
CEDAR CREEK, QLD  
COORDINATE SYSTEM  
GDA 2020 MGA Z56  
SCALE (A4)  
1:12,000



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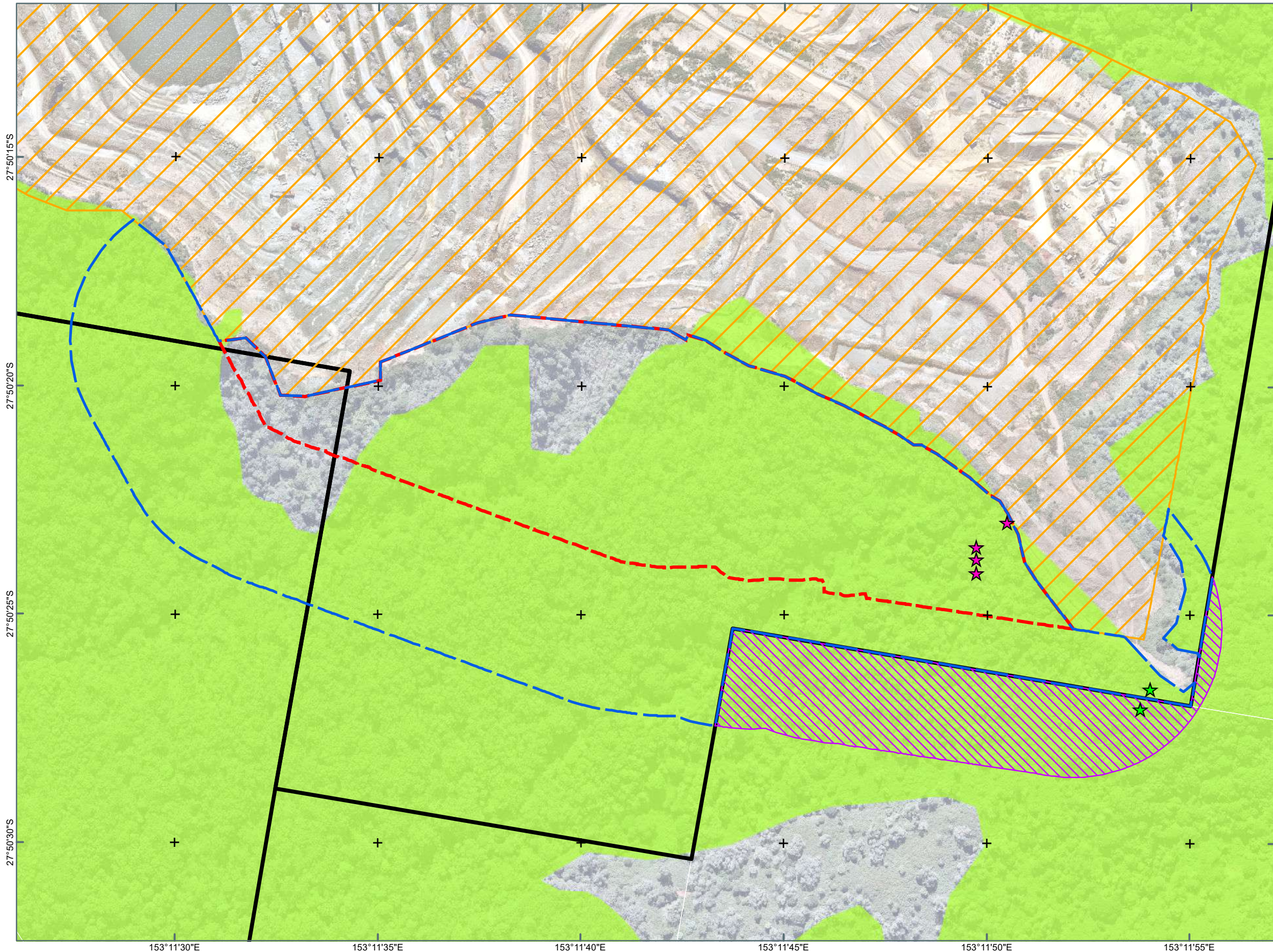
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FILE REFERENCE

11390 E MIMP Figure 4 SVM A

DATE 8/10/2025

# PLAN A1. CLEARING IMPACT AREA AND SURVEY RESULTS



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## LEGEND

- Qld DCDB
  - Site Boundary
  - Existing Quarry Area
  - Referral Area [5.9 ha]
  - Clearing Impact Area
  - Access Not Possible On Neighbouring Properties
- NCA Protected Plants**
- High risk area - flora survey trigger
  - Macadamia integrifolia* specimen(s) located within referral area  
 Specimen(s) [15]  
 Location(s) [4]
  - Macadamia integrifolia* specimen(s) located outside referral area  
 Specimen(s) [1]  
 Location(s) [1]



## 2.4. Avoidance and minimisation of impact

Blue Rock Quarry is located within the Gold Coast City Council (GCCC) local government area and is zoned 'Extractive Industry' under the *Gold Coast City Plan 2017*. In addition to local government zoning, the quarry area is also identified as Key Resource Area (KRA) 62. KRAs are identified in the *State Planning Policy*, with a total of 165 designations existing across Queensland. State intent of the designation is to protect land from development that could compromise the ability to access, extract and transport significant resources in the future.

The initial extraction approval was obtained in 1972 with quarry operations running through 5 decades to the present day. A range of other State and Local approvals have been obtained over the years including Environmental Authorities (EAs) that outline management requirements for the extraction activities, and operational works permits that allow vegetation clearing for approved extraction activities to occur. The current extent of the extraction area was reached in approximately 2005, with vegetation within the area being cleared and regrowing in cycles to support extraction activity. Regarding the expansion area, the following State and local Council approvals have been obtained:

- Environmental Authority P-EA-100268669 which includes extraction and screening activities for up to 1,600,000t per year on Lot 89 on WD739 and Lot 1 on SP238024.
- Clearing of remnant vegetation within the expansion area through DNRM permits RARP 2011/006373 and DPP 2005/101762
- MCU201400231 Material Change of Use Development Approval issued by Gold Coast City Council
- 306/3/248 (1977) Rezoning Approval for Extractive Industry issued by the then Albert Shire Council

As mentioned in previous sections, *Macadamia integrifolia* specimens were recorded within the clearing impact area, which includes both the 'area to be cleared' and the associated 100 m buffer. While it is not possible to avoid impacts to specimens within the clearing area, mitigation measures will be implemented for those specimens directly and potentially indirectly impacted as part of the quarry expansion. Proposed management and mitigation measures are discussed in **Section 3**.



# 3. Management of impact

This section contains justification for, and details on, the specific management strategies to be implemented prior to commencement of vegetation clearing works, during operational works, and post construction works on the subject site to ensure potential impacts on *Macadamia integrifolia* (Macadamia Nut) are mitigated and/or minimised.

## 3.1. Risk of impact

The Department of Climate Change, Energy the Environment and Water (DCCEEW) Recovery Plan for *Macadamia integrifolia* (Macadamia Nut) was utilised to provide information on specific threats to the species with relevance to the site being addressed in this IMP.

The Recovery Plan Guideline details the following threats to the species

- Habitat loss and fragmentation
- Small Populations
- Weed species
- Fire
- Unmanaged Livestock
- Climate Change
- Genetic Pollution
- Disease

### 3.1.1 Habitat loss and fragmentation

The long-term impacts of land clearing and habitat fragmentation are underlying factors contributing to the threatened status of *Macadamia integrifolia*. This is exacerbated by ongoing clearing of remnant bushland throughout the species range for horticulture, agriculture, urban and industrial development, and associated infrastructure activities. The 'area to be cleared' consists of a mixture of remnant and non-remnant vegetation the latter of which contains regrowth vegetation reflective of pre-clear RE 12.11.10 and 12.11.3. Due to RE 12.11.3 being dominant, the majority of the area to be cleared does not contain suitable habitat for *Macadamia integrifolia*. However, the eastern extent of the expansion area contains 1.1 ha of regrowth reflecting RE 12.11.10, which is recognised as habitat for *Macadamia integrifolia*.

The extent of mapped remnant and high-value regrowth vegetation containing RE 12.11.10 within the broader landscape is vast, extending east and north from the Blue Rock Quarry's boundary. A significant portion of mapped RE 12.11.10 has been historically cleared throughout the region, resulting in a dominance of high-value regrowth vegetation with smaller pockets of remnant. As a result, areas of RE 12.11.10 within the clearing impact area contain significant disturbance and weeds dominating the understory. In addition, the vegetation lacks maturity and is dominated by regrowth specimens, further evidence of historical disturbance. Given the small size and disturbed nature of the vegetation, the proposed impact to regrowth RE 12.11.10 within the expansion area will not significantly reduce the extent of *Macadamia integrifolia* habitat, particularly given the extent of suitable habitat in the broader landscape.



### 3.1.2 Small population size

The *Macadamia integrifolia* Recovery Plan indicates that genetic drift, loss of genetic diversity, inbreeding depression, factors affecting reproductive success, and ability to sustain critical population size all affect the viability of the threatened species. When population size is reduced, genetic diversity can be reduced, and therefore population viability may be compromised.

The proposed clearing activities will retain some specimens that were recorded outside of the direct clearing area, retaining a population with some genetic diversity. Whereas the specimens that will be unavoidably removed as part of the quarry expansion will be offset in the local area within suitable habitat at a ratio of 4:1. The planted specimens will be propagated from those individuals to be impacted ensuring genetic diversity is maintained at the site. Mitigation measures will maintain genetic diversity of the local population and ultimately provide a net gain in overall population numbers within the region. Details on retaining genetic diversity through propagation efforts are discussed in **Section 5.1**.

### 3.1.3 Weeds

Invasive species can physically displace native flora, compete for resources (such as pollinators, light, nutrients and water), and create habitats that are conducive to other exotic species. Weed species that pose a direct and significant threat to *Macadamia* habitats are dense shrub Lantana (*Lantana camara*), and exotic vines Cat's Claw Creeper (*Dolichandra unguis-cati*) and Madeira Vine (*Anredera cordifolia*), which form a smothering habit through native canopy and shrub layers.

As a result of historical rural land-uses, the majority of the vegetation reflecting RE 12.11.10 within the clearing impact area is dominated by *Lantana camara* (Lantana). Where *Lantana camara* (Lantana) is abundant, it significantly reduces the recruitment of native species which was evident throughout the protected plant survey area. Notably, *Macadamia integrifolia* specimens were recorded in locations where *Lantana camara* (Lantana) infestations were lower, which reflects the highly suppressive nature of this invasive species. As the area is already significantly affected by invasive species, it is therefore considered highly unlikely that the clearing proposed will increase weeds that are not already abundant in the area. Furthermore, the site is managed under an existing Environmental Management Plan which details site protocols to minimise the spread of weeds.

### 3.1.4 Fire

The Recovery Plan indicates that *Macadamia integrifolia* and related species are particularly sensitive to fire. In general, due to their moist composition rainforest communities are normally less susceptible to wide spread bushfires, and do not facilitate the spread of fire. However, rainforest remnants containing edges infested with flammable weeds such as *Lantana camara* (Lantana) or exotic grasses are more susceptible to direct threat from bushfires, as is the case with the vegetation present on-site. In addition, extreme drought conditions exacerbated by Climate Change have increased the potential for and severity of rainforest fires (Thorley, J. *et al* 2023). As the majority of the clearing impact area is infested with *Lantana camara* (Lantana) the susceptibility of the area to high severity fires is considered significant. Subsequently, it is unlikely that the proposed clearing will increase the prevalence of weeds and therefore increase the risk of fires that are not already present.



### 3.1.5 Unmanaged Livestock

When access is given, livestock will utilise *Macadamia* habitat for shade, water (gallery and riparian rainforests) and grazing. Where unmanaged this has the potential to:

- modify the vegetation structure and floristic composition, cause loss of habitat diversity, initiate and exacerbate soil erosion (with consequent effects on water quality),
- facilitate the introduction and spread of invasive weeds
- particularly exotic pasture grasses and legumes
- and alter the amount and distribution of fuel throughout the landscape potentially increasing the incidence, intensity and extent of fires.

Cattle crazing is not permitted within the quarry nor are surrounding properties utilised for this; therefore, the proposed clearing will not increase the likelihood of livestock presence.

### 3.1.6 Climate Change

Not applicable to the scope of this project. It is unlikely that the proposed clearing will significantly increase the threat of climate change.

### 3.1.7 Genetic Pollution

Genetic pollution DNA marker studies have confirmed hybrid genotypes of *Macadamia integrifolia* and *M. ternifolia*, and *M. integrifolia* and *M. tetraphylla* occur within a 20 km overlap zone where both species co-occur within the same rainforest patch (Peace, 2005). This natural predisposition for hybridisation has been found to be causing genetic 'pollution' of wild populations. Both *M. integrifolia* and *M. tetraphylla* are known to occur in the broader locality of the Tamborine region and is identified as an area where hybridisation occurs. Therefore, the proposed clearing of highly disturbed regrowth vegetation is highly unlikely to increase genetic pollution that is not already present. Planting specimens will be propagated directly from those trees to be impacted reducing the risk of genetic pollution.

### 3.1.8 Disease

Phytophthora root rot is a major problem for the Australian *Macadamia* industry and is a serious threat to wild populations. Of the Phytophthora species impacting *Macadamia*, *Phytophthora cinnamomi* is most widespread, has frequent impact and is the most devastating. If left untreated, *P. cinnamomi* causes stem canker, root rot, tree decline, dieback and tree death.

With the implementation of standard vehicle washdown and hygiene procedures, proposed clearing is not considered likely to increase the risk of disease into the area. Furthermore, indirect impacts are to be mitigated through stormwater and dust management.



## 3.2. Prior to vegetation clearing

Prior to the commencement of vegetation clearing, the clearing area will be pegged out by surveyors and the boundary between the vegetation to be removed and to be retained is to be clearly delineated with tape, fencing or signage. No clearing is to occur outside nominated clearing zones and contractors shall not enter areas of retained vegetation.

The individual threatened plants (or area) to be retained will be identified and marked on construction plans prior to the commencement of site preparation works. Extraction will be staged to allow sufficient time for individual threatened plants located within the impact area to be retained long enough for propagation to occur as detailed in **Section 5.1.1**. (refer Plan 2 for indicative staging).

## 3.3. During operation works

This section contains specific management strategies for mitigating and/or minimising the potential impacts on *Macadamia integrifolia* (Macadamia Nut) and its associated habitat during construction works.

### 3.3.1 Vegetation protection guidelines

All vegetation clearing and operational works will be contained and limited to the expansion area (5.9 ha). Further, individual trees to be removed will be felled in a direction away from retained *Macadamia integrifolia* (Macadamia Nut) specimens.

Outside of the approved clearing zone, the following activities shall not be permitted:

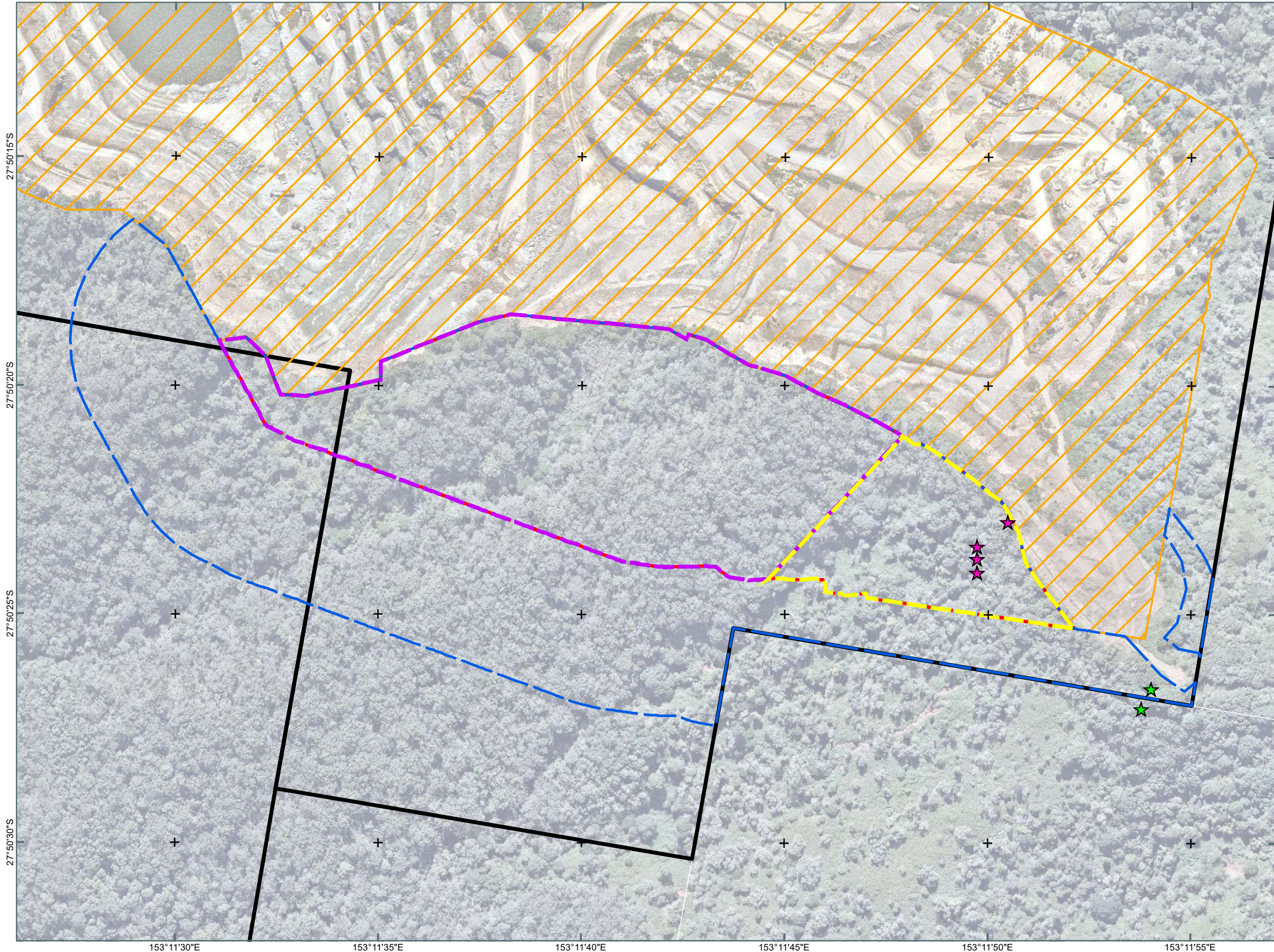
- Storage and mixing of materials;
- Storing machinery
- Liquid disposal;
- Combustion of any material;
- Stockpiling of soil, rubble or debris; and
- Unauthorised pesticide, herbicide or chemical applications.

### 3.3.2 Prevention of erosion

Stormwater within the quarry area will be managed in accordance with the Stormwater Management Plan in effect for existing operations, provided as **Appendix B** - Stormwater Management Plan. This management plan outlines principal objectives and how they are to be achieved including adequate control measures to manage runoff from site, preservation of water quality downstream and also provide a framework for surveillance, response and reporting. Further proposed stormwater runoff management controls will be designed in accordance with the Queensland Urban Drainage Manual (QUDM), as per industry standards.



# PLAN A2. IMPACT PLAN



**Notes:**  
 The information on this plan is not suitable for any purpose other than the expressed use of the Client. Property dimensions, areas, numbers of lots and contours and other physical features may need verification if the development application is approved and development proceeds, and may change when a full survey is undertaken or in order to comply with development approval conditions. No reliance should be placed on the information on this plan for detailed design or for any financial dealings involving the land. Saunders Havill therefore disclaims any liability for any loss or damage whatsoever or howsoever incurred, arising from any party using or relying upon this plan for any purpose other than as a document prepared for the sole purpose of accompanying a development application and which may be subject to alteration beyond the control of Saunders Havill. Unless a development approval states otherwise, this is not an approved plan.

**Layer Sources**  
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 Updated data available at <http://qlds.patial.information.qld.gov.au/catalogue/>  
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## LEGEND

- Qld DCDB
- Site Boundary
- Existing Quarry Area
- Referral Area [5.9 ha]
- Indicative Extractive Staging**
- Stage 1 [4.6 ha]
- Stage 2 [1.3 ha]
- Clearing Impact Area
- Impacted *Macadamia integrifolia* specimen(s) located within referral area  
*Specimen(s)* [15]  
*Location(s)* [4]
- Retained *Macadamia integrifolia* specimen(s)  
*Specimen(s)* [1]  
*Location(s)* [1]



# 4. Proposed Planting Area assessment

Over the extent of its natural distribution, *Macadamia integrifolia* is generally found within lowland warm complex *notophyll vine forest* and *Araucarian notophyll vine forest* that occur on metamorphosed sediments and interbedded volcanics or alluvia in higher rainfall areas. This species occupies all topographic positions including ridges, scree slopes, foot slopes, gullies, benches and riverine terraces. Soils are predominantly alluvial or volcanic, well drained, often with significant surface exposure of rock fragments, however slope and aspect vary. The currently recorded extent of occupied habitat is approximately 1,500ha and the modelled extent of Elevation range is 5–600m. Habitat critical to the survival of *Macadamia integrifolia* is identified to be in association with RE 12.3.1, RE 12.8.3, RE 12.11.10 and RE 12.12.16.

Vegetation mapped as RE 12.11.10 is abundant within the broader locality that could support the supplementary *Macadamia integrifolia* specimens. As such, an area in the north of the Fulton Hogan land holding has been identified as a suitable planting area for several reasons, which are discussed below.

## 1. Habitat suitability

Any proposed planting area needs to be of a suitable habitat type to ensure planted *Macadamia integrifolia* specimens have the best chance of survival. Vegetation within the northern extent of the Fulton Hogan land holding is mapped as RE 12.11.10, containing a mixture of remnant and high-value regrowth communities. Under the National Recovery Plan for *Macadamia* species (DCCEEW 2023), this regional ecosystem is a recognised habitat community for *Macadamia integrifolia* and aligns with the vegetation type where the specimens proposed for removal currently exist. The area of RE 12.11.10 within the land holding is also mapped as present to the north and east within neighbouring private properties, thus forming a large area of continuous suitable vegetation able to support *Macadamia integrifolia*.

While the Planting Offset Area (POA) was identified through desktop assessments and vegetation mapping as potential habitat to support *Macadamia integrifolia*, on-ground confirmation of habitat suitability was required. Subsequently, on 2 September, two (2) suitably qualified Ecologists from SH carried out a visual inspection of the area and identified *Mallotus philippensis* (Red Kamala), *Aphananthe philippinensis* (Rough-leafed Elm) and *Ficus watskinsiana* (Strangler Fig) to be present which are indicator species of RE 12.11.10 (refer **Photo Set 1**). Portions of this area observed to contain evidence of prior clearing and disturbance, likely a result of historic rural land-uses. These disturbed areas are reflected in the VMA mapping. The POA includes 1.77 ha of mapped RE12.11.10 to receive planted *Macadamia integrifolia* (refer **Plan 3**)





**Photo set 1:** Proposed planting area contains species indicative of RE12.11.10 with some areas having been historically cleared.

## **2. Context**

This POA occurs within the northern extent of the Fulton Hogan landholding within a portion of the site not proposed for extraction activities. The location of this area several hundred meters from the current quarry pit and associated infrastructure limits potential edge effects and indirect impacts from extraction activities. Furthermore, where offsetting species, it is most beneficial for proposed offset planting sites to occur as close to the impact area as possible (i.e < 5 km). This contributes to maintaining the population as a whole and ensures conditions, such as climate, rainfall, and necessary pollinators, remain similar to where wild specimens occur to increase the chance of the planted specimen's survival.

The proposed planting area is approximately 1.5 km north-west of the clearing impact area and therefore planted specimens will have a net gain on the local population and occur in conditions alike to the impacted specimens.

## **3. Access**

The topography of the POA is steep, which is typical for the region and reflects surrounding areas of vegetation containing RE 12.11.10. However, the POA is readily accessible from Schmidt Road which, from



an operational works perspective, allows for access during the establishment, monitoring and maintenance of the planted specimens.

#### 4. Population and Records

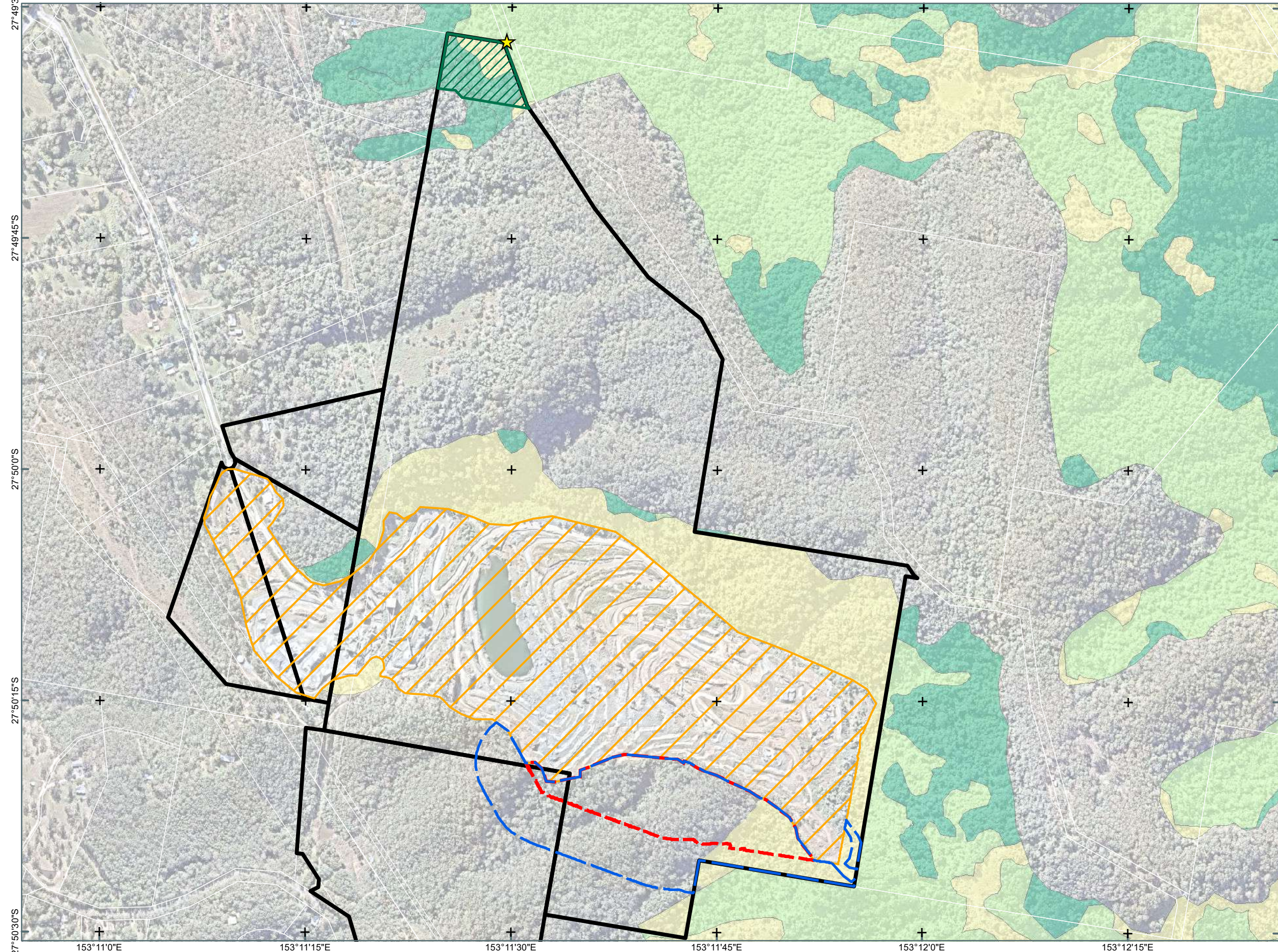
While the POA is within close proximity to the clearing impact area, the presence of local contemporary records of *Macadamia integrifolia* provides security that the POA is likely to be suitable to support the planted specimens. A desktop search of species records identifies several records of *Macadamia integrifolia* as occurring within 5 km of the POA, occurring within remnant and regrowth vegetation to the north and south of the land holding.

Furthermore, during an initial suitability assessment of the POA, several *Macadamia integrifolia* specimen was observed on the northern side of Schmidt Road where mapped high-value regrowth RE 12.11.10 is present (refer **Photo Set 2**). The presence of this specimen and confirmation of suitable vegetation community provides further confidence in the suitability of the POA.



**Photo set 2:** Existing *Macadamia integrifolia* north of Schmidt Road, adjacent to proposed planting area

# PLAN A3. PROPOSED PLANTING AREA



**Notes:**  
 The information on this plan is not suitable for any purpose other than the expressed use of the Client. Property dimensions, areas, numbers of lots and contours and other physical features may need verification if the development application is approved and development proceeds, and may change when a full survey is undertaken or in order to comply with development approval conditions. No reliance should be placed on the information on this plan for detailed design or for any financial dealings involving the land. Saunders Havill therefore disclaims any liability for any loss or damage whatsoever or howsoever incurred, arising from any party using or relying upon this plan for any purpose other than as a document prepared for the sole purpose of accompanying a development application and which may be subject to alteration beyond the control of Saunders Havill. Unless a development approval states otherwise, this is not an approved plan.

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## LEGEND

- Qld DCDB
- Site Boundary
- Existing Quarry Area
- Referral Area [5.9 ha]
- Clearing Impact Area
- QLD VMA mapping**
- VMA Category B - RE 12.11.10
- VMA Category C - RE 12.11.10
- VMA Category X - (preclear RE 12.11.10)
- Planting Offset Area (POA) [1.77 ha]
- Macadam integrifolia* Observation



# 5. Management Action 1 – Direct Planting

To ensure the survival of the *Macadamia integrifolia* species in the wild, direct supplementary planting will be undertaken to replace those individuals directly impacted. Impacted individuals will be replaced at a ratio of 4:1 to provide a net gain in specimens to the area, which will be planted in the POA in the north of the Fulton Hogan land holding (refer to Plan 2). The POA and planting procedure including timings and maintenance measures is described in detail in this section.

## 5.1. Propagation Measures

While *Macadamia integrifolia* specimens are readily available as a cultivar through nurseries, due to their use in horticulture, these specimens generally have less genetic diversity than wild specimens due to the widespread use of grafting, which results in genetically uniform cultivated plants. Cultivated specimens are less able to adapt to a range of environmental conditions and grafted specimens with limited genetic variability would be susceptible to being wiped out from a singular traumatic event such as disease and pests due to a limited potential for diverse beneficial traits to be present.

Furthermore, a study on wild and domesticated *Macadamia* genetic diversity by Southern Cross University found that the South-east Queensland populations of *Macadamia integrifolia* differ based on five main genetic clusters which generally correspond with geographic regions. The specimens proposed for impact occur within the genetic group designated as “South Brisbane to Gold Coast hinterland (Mt Cotton to Beechmont)”. This study also found that most Australian cultivars are derived from the Mt Bauple and the Gympie region genetic groups of the *Macadamia integrifolia* and therefore may face different conditions and life history to those within the Gold Coast Hinterland Region (Nock, 2020). Further indicating the need to propagate specimens from individuals within this genetic region to bolster genetic diversity of the local population and survivability of planted specimens.

### 5.1.1 Propagation methodology

Fulton Hogan have engaged a third-party specialist (Adjunct Associate Professor Albano Mucci, University of Queensland) to provide guidance and coordinate works necessary to fulfill this offset requirement.

Albano Mucci is an experienced field Ecologist with over 20 years in conservation planning and management with an expertise in design and development of studies associated with threatened species (flora and fauna). The information provided in this document has been developed with guidance from Albano Mucci.

Several methods have been considered to achieve the required offset ratio for the project (4:1) including transplanting of individual specimens from the expansion area. While transplanting of *Macadamia sp.* has been successful on nearby projects including the Tugun Bypass Project (DTMR 2004) and Beechmont Road Project (Reynolds 2011), transplanting alone will not yield the net gain in specimens (i.e. 4:1 ratio).

A range of propagation methods have been investigated to achieve the required offsets ratio. These methods are described below:



- **Seed collection or cuttings:** Studies have found that propagating wild *Macadamia integrifolia* from seed can be difficult, as the species generally produces fewer mature nuts viable for propagation (McConachie 2010). Additionally, propagating *Macadamia integrifolia* from seed can take several years to establish a plant suitable for planting with commencement dependent on time of year. The specimens proposed to be impacted vary from juvenile to semi-mature specimens and as such seed collection is uncertain.

**The collection of germplasm (i.e tissues) via 'air layering':** The 'air layering' process is a vegetative propagation method used for the establishment of macadamia (*Macadamia integrifolia* and *Macadamia tetraphylla*) that produces clonal plants genetically identical to the parent material. The technique involves the selection of healthy branches, typically 10–20 mm in diameter, from mature/semi-mature trees. A section of bark from the branch is removed to disrupt phloem transport, and the exposed area is treated with a rooting hormone to promote root formation. The wound is then enclosed with a moist rooting medium, commonly sphagnum moss, and sealed to maintain humidity. Root development generally occurs within 3 months but can be up to 6 months. Once the air layered branch is considered to be sufficiently rooting as determined by the suitably qualified environmental person, the branch is detached and transplanted into a pot which is stored in nursery ready to be planted. Air layering is a successful method of cultivation (>70% success) if completed correctly by a suitable qualified environmental person (typically horticulturalists).

The main benefits of air layering over seed collection is the timeframe from propagating to an established sapling ready for planting is significantly reduced. Seed collection is reliant on several variables which cannot be controlled such as timing and seed yield. These variables are more easily controlled with the air layering technique which allows multiple specimens to be harvested from the same tree irrespective of whether seeding is occurring and provides greater confidence in the expected yield.

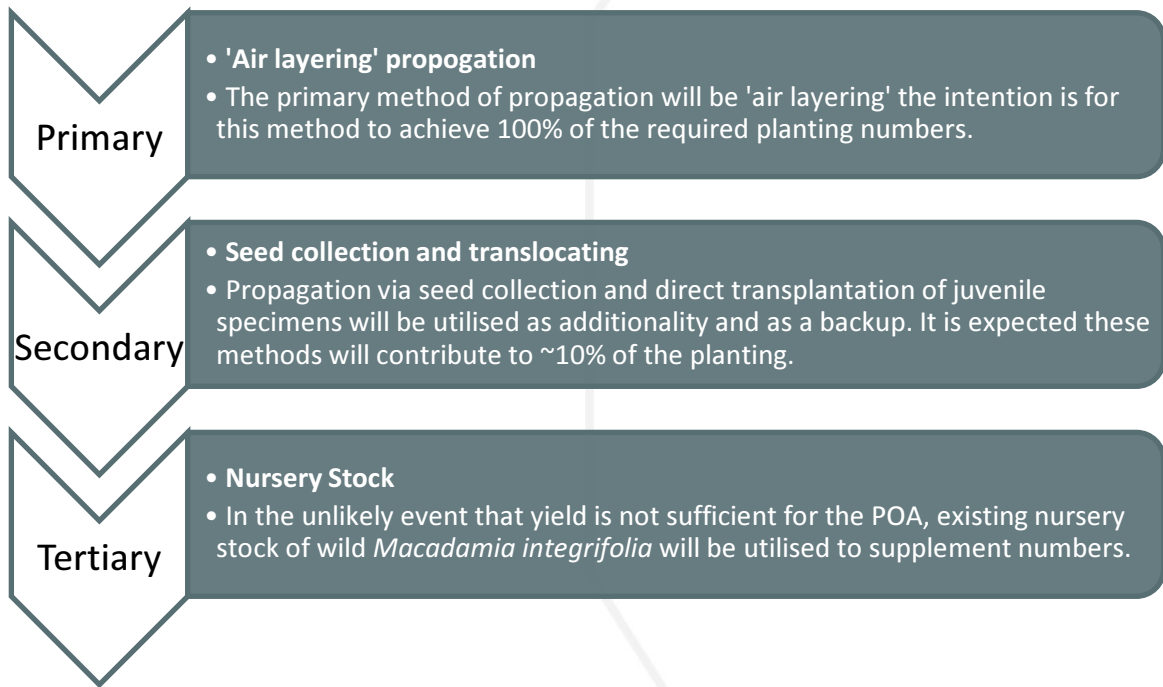
Propagation of *Macadamia integrifolia* for cultivation and horticulture is relatively common however fewer studies on the propagation of wild *Macadamia integrifolia* for conservation exist. The method of collection of germplasm (i.e tissues) via 'air layering' propagation for conservation has occurred with *Macadamia integrifolia* cuttings been successfully propagated during other projects in the Gold Coast area (Hinze Dam Alliance 2008). This method is also documented as suitable in *Wild Macadamia Conservation*, Rahman (2020), and Nagao and Hirae (1992).

A site inspection by SH and Albano Mucci was completed on 4 February 2026 to ascertain the quality of the existing *Macadamia integrifolia* specimens for 'air layering.' It was concluded during this assessment that there is sufficient numbers and quality at the impact site to achieve 100% of the required planting numbers by air layering. Suitable *Macadamia integrifolia* were flagged for future reference (refer **Photo set 5**)

While the intention is for all planting stock to be propagated by air layering several additional techniques may be utilised as a failsafe should yield not be adequate. The order of priority propagation methods is provided in **Insert 1**

A total of 60 specimens is required to meet the 4:1 ratio. To account for potential failure, 75 specimens will be sourced.





**Insert 1:** *Planting stock methods order of prioritisation*



**Photo set 3:** *Macadamia integrifolia* intended to be impacted flagged in preparation for propagation

## 5.2. Planting, Maintenance and Monitoring

To ensure the planted *Macadamia integrifolia* (Macadamia Nut) have the best chance of survival and ultimately provide a no net loss of *Macadamia integrifolia* in the area, a maintenance and monitoring program will be implemented that outlines requirements during planting, establishment, and maintenance phases through to completion.

### 5.2.1 Planting

Specimens will be planted within suitable areas of the POA site following the site preparation including weed removal and erosion control as determined by the suitably qualified environmental person as appointed by the approval holder. All planting stock will be advanced tube stock, well-formed and hardened off to suit final revegetation location and increase chances of survival. Specific planting locations are to be determined by a suitably qualified environmental person based on site conditions and access and will be designed to replicate a natural setting (i.e not planted in rows).

There is little documented evidence of wild *Macadamia integrifolia* density that is not highly variable. This is largely a result of varying site conditions associated with vine thicket vegetation and long history of disturbance and fragmentation of suitable habitat across SEQ. Pisanu et al (2009) concluded reproductive success of wild Macadamia requires neighbouring trees within 10–20 m, implying naturally close spacing amongst individuals. While this study was specifically detailed *Macadamia tetraphylla*, the species are genetically very similar and have overlapping habitat.

Planted stock will be planted in clusters of 5-10 individuals as directed by suitable qualified environmental person (Albano Mucci) to mimic natural composition and characteristics of the species in the wild as identified at the expansion area. Large mature wild *Macadamia integrifolia* were observed in clusters to the north of Schmidt Road near to the POA. Planted specimens will be clearly marked and GPS locations recorded and provided to all necessary contractors.

As detailed in **Table 4**, propagation will start prior to the commencement of the action and continue for approximately 12 months until such time that specimens are considered suitable for planting. The action will commence provided propagation has begun and the proposed planting area has been legally secured via a Voluntary Declaration (refer **Section 6**).

**Table 4: Proposed propagation and planting timeframe**

Timing	Detail
<b>Prior to commencement of the action</b>	<ul style="list-style-type: none"> <li>• Air layering of suitable trees within the expansion area commences.</li> <li>• Completed by suitable qualified practitioner utilising the methodology detailed in Section 5.1</li> </ul>
<b>3-6 months</b>	<ul style="list-style-type: none"> <li>• The air layering is assessed for evidence of root formation.</li> <li>• If considered adequate, the branch is detached, removed from site and planted in a pot</li> </ul>



	<ul style="list-style-type: none"> <li>• If roots formation is inadequate, propagation is re-checked every month until considered suitable</li> </ul>
<b>6-12 months</b>	<ul style="list-style-type: none"> <li>• The harvested plants are grown in a nursery and monitored until they are considered suitable for planting</li> <li>• The Planting Offset Site is prepped.</li> <li>• Planting locations determined</li> <li>• Weed removal</li> <li>• Soil testing to highlight if plants need any supplementary feeding at time of planting.</li> </ul>
<b>Year 2</b>	All plantings completed within 2 years from the commencement of the action

### 5.2.2 Establishment Phase

The establishment phase of planting occurs up to 12 weeks post planting. At this point, planted stock are under the most amount of stress as they adapt to the new area. As such, frequent care and monitoring is required to ensure survival. Planted specimens will be advanced tubestock reducing the risk of planting failure.

Sufficient watering, as determined by the suitably qualified environmental person, will be carried out at the time of planting when the tube stock is most susceptible to drying out. Following initial planting, the tubestock will be left to establish within the prevailing climatic conditions with regular monitoring (approximately every 2-4 weeks) of their progress during the establishment phase as considered necessary by the suitably qualified environmental person. If it is observed during this phase that the plant is under stress, then a subsequent watering event will be required as directed by the suitably qualified environmental person. Dense weed infestations within the specific planting locations will be treated prior to plantings and will continue to be monitored and suppressed where regrowth is observed. Best practice weed management techniques will be employed for weed removal amongst revegetation areas to ensure planted specimens are not impacted.

To retain the net gain expectation, an 80% success rate for planted *Macadamia integrifolia* is required by the end of the establishment period. Where die-off occurs at greater than 20% during the initial 12-week period, lost specimens will be replanted by the suitably qualified environmental person. All replacement plants shall be of the same quality and propagated from the same process as detailed in **Section 4.2.1**.

### 5.2.3 Maintenance Phase

The maintenance phase of the planting area occurs from 13 weeks to 2 years post planting. No specific watering regime is provided during the maintenance period. The intent is for the area to become self-sufficient in utilising natural rain patterns and run off and ensures specimens do not become reliant on artificial water regimes. However, the planting area will be monitored on a quarterly basis up to 2 years where implementation of adaptive management will be carried out as appropriate guided by the suitably qualified environmental person.



### 5.2.4 Maturity phase

The maturity phase is defined as from 2 years post planting up until plants are considered ‘mature.’ The National Recovery Plan for Macadamia Species (DCCEEW 2023) states that maturity of *Macadamia integrifolia* occurs at around 10 years. This timeframe is potentially variable depending on external factors and is measured as growth from seed. Planted specimens proposed as part of this project will be advanced tube stock and therefore are already progressed beyond the initial seedling phase.

Seeding of planted trees indicates that *Macadamia integrifolia* are progressing towards maturity. While they may not have reached full maturity by this stage signs of seeding gives a clear indication that plants are self-sustaining and maturing. For the purposes of providing clear definition of ‘maturity’ for this project maturity will be considered achieved if the majority (>50%) of planted specimens have been observed to be seeding or 10 years has passed since planting completion (whichever occurs first). Annual monitoring will occur during this phase. Utilising seeding as a metric for maturity allows assessment to be site specific as opposed to only a broad timeframe.

Maturity defined as:

- Majority (>50%) of planted specimens have started seeding, or
- 10 years has passed since planting was complete

### 5.2.5 Completion Phase

Once planted specimens are considered mature as detailed in **Section 5.2.4** annual monitoring for 2 years will occur signifying completion criteria have been achieved.

### 5.2.6 Monitoring

A summary of monitoring schedule and frequency is provided in **Table 5**.

**Table 5: Monitoring schedule**

Monitoring Action	Timing			
	Establishment Phase (first 3 months following planting)	Maintenance Phase (From 13 weeks to 2 years following planting)	Maturity Phase (from 2 years until plants are considered mature)	Completion Phase (from when plants are considered mature for 2 years)
Direct planting	Every 2-4 weeks (approximately)	Every 3 months	Annually	Annually

### 5.2.7 Reporting

A Planting Offset Area Report (POAR) will be developed by the suitable qualified environmental person as appointed by the Proponent following each monitoring period. This POAR will include but is not limited to the following:



■ *Macadamia integrifolia* Impact Management Plan

- Status of clearing area
- Status of planting area
- Physical count of planted specimens (>80% success rate)
- Status of planted specimens
  - Size/maturity/evidence of seeding
- Where and if any remedial actions had taken place
- Issues affecting the rehabilitation area and any rectification works undertaken
  - Supplementary watering, tree guards, weed removal
- Recommendations

**Annual Compliance Report (ACR)**

An ACR will be prepared in line with any conditions associated with EPBC approval. The POAR will be included as part of the ACRs. The reporting period for the action will be the year following the commencement of the action.

The ACR will be prepared by a suitable qualified environmental person as directed by the Proponent and published on the project website each year by the conditioned date. The report will address the compliance with each of the conditions of approval for the project. Documentary evidence providing proof of the date of publication of the ACR and non-compliance with any of the conditions of the approval will be provided to DCCEEW at the time of publishing the compliance report if the action is approved.

5.2.8 Management Action Completion Criteria

Timing	Completion Criteria
Year 10 post planting	Planted stock reach the definition of mature being 50% of the stock are seeding or 10 years has passed since planting.



# 6. Management Action 2 – Legal securement

The POA must be protected for *Macadamia integrifolia* offsets to attain a conservation gain. The POA will be legally secured prior to commencement of the action via a Voluntary Declaration (VDec) administered under the VMA. Notification of declaration will be supplied to DCCEEW.

A covenant under either Chapter 6 Part 4 Division 8A of the *Land Act 1994* (Qld) or Part 6 Division 4A of the *Land Titles Act 1994* (Qld) will be registered within 12 months of commencing the action. If a covenant is not possible an alternative legally binding mechanism will be implemented in consultation with DCCEEW.

The declared area will be recognised as making significant contribution to the conservation of *Macadamia integrifolia*. Demonstration of this management action will be provided in the ACRs.

## 6.1.1 Management Action Completion Criteria

Timing	Completion Criteria
<b>Prior to commencing the Action</b>	Legally secure the proposed planting area via a Voluntary Declaration (VDec) administered under the VMA and notify DCCEEW.
<b>Year 1</b>	Register a covenant under the Land Act 1994 (Qld) and notify DCCEEW within 20 business days.
	If a covenant is not possible an alternative legally binding mechanism will be implemented in consultation with DCCEEW.



# 7. Adaptive Management

An adaptive implementation program will be used to ensure uncertainty is reduced over time, and that completion criteria are attained and maintained for the life of the offset. As more information becomes available following ongoing monitoring, the management and monitoring regime will be reviewed and revised to maximise the likelihood of attaining and maintaining the outcomes to be achieved by implementing the IMP.

Adaptive management will be used to incorporate changes in any of the following areas:

1. Assimilation of new data or information – such as, updates to conservation advice or new threat abatement plans relevant to *Macadamia integrifolia*.
2. Project coordination and scheduling – to manage unforeseen disruptions to schedule such as inclement weather on contractor works for management actions and environmental consultant monitoring events.
3. Annual review of risks – to refresh the mitigation measures should new threats be identified or stochastic events such as unplanned fires or floods occur.
4. Annual review of management measure effectiveness – to increase the frequency or change the method of management actions where completion criteria is not being met.
5. Contingency for unplanned incidents – such as stochastic events including unplanned fires or floods.

Changes to the management plan resulting from the adaptive management process will be reported to DCCEEW differently depending on whether they are minor, major or urgent. These are defined as:

- **Minor Change** – has no potential to alter any of the environmental outcomes or completion criteria specified in the management plan. A notification will be provided to DCCEEW at least 10 bd prior to the change occurring.
- **Major Change** – has potential to alter the environmental outcomes or completion criteria specified in the management plan. A notification requesting approval for the change will be provided to DCCEEW prior to the change occurring.
- **Urgent Change** – actions that are required to be taken to address an urgent matter. Changes will be implemented immediately at the direction of a suitably qualified expert with notification sent to DCCEEW as soon as practical but no more than 10 business days after the change occurs. An example of an urgent change could be an increase in buffers or removal of understorey vegetation in response to an intense bushfire.

The notification for any change will be accompanied by documentation addressing at a minimum:

- A description of the proposed change including identification of specific management measures to be altered and how the changes will be implemented.
- Target outcomes of the proposed change including alterations to environmental outcomes or completion criteria if applicable.
- Proposed monitoring regime to demonstrate the outcomes of the change.
- Future reporting requirements with monitoring outcomes to be provided to DCCEEW no more than 6 months after the commencement of the change.



- If the target outcomes have not been achieved reporting must include response actions and ongoing monitoring requirements.

Once the target outcomes have been achieved notification will be provided to DCCEEW stating that the change will be permanently included in the management plan. The changed management measure will continue to be monitored as part of general compliance reporting unless otherwise specified.

In the case of an urgent change notification and documentation may be provided retrospectively.

### 7.1.1 Risk of Failure

The plan assesses the risk of failure to achieve the plan's environmental outcomes and completion criteria. A review of the identified risks to *Macadamia integrifolia* (refer Section 3.1) has been revisited for the POA with reference to the proposed management actions detailed in **Section 5** and **Section 6**

To identify the risk of failure, **Table 6** states the management action, completion criteria, risk of failure, monitoring and correcting actions.

#### **Habitat Loss and Fragmentation**

One of the primary threats to *Macadamia integrifolia* is habitat loss and fragmentation. The POA will be legally secured via a Voluntary Declaration (VDec) administered under the VMA. To ensure legal protection of the POA in perpetuity the POA will be registered as a covenant under the Land Act 1994 (Qld). If a covenant is not possible an alternative legally binding mechanism will be implemented in consultation with DCCEEW.

#### **Small population size**

The proposed clearing activities will retain some specimens that were recorded outside of the direct clearing area, retaining a population with some genetic diversity. Whereas the specimens that will be unavoidably removed as part of the quarry expansion will be offset in the local area within suitable habitat at a ratio of 4:1. This mitigation measure will maintain genetic diversity of the local population and ultimately provide a net gain in overall population numbers within the region.

#### **Weeds**

As identified at the impact site, dense weeds (primarily *Lantana camara*) were observed which plays a significant role in suppressing native regeneration. The planting of *Macadamia integrifolia* at the POA will include site preparation works including weed management. The planted stock will be monitored as detailed in Section 5.2 until they reach maturity. Once plants have reached maturity as defined in Section 5.2 the threats of weeds negatively impacting growth is significantly reduced.

#### **Fire**

While no specific Bushfire management plan is in effect at the site, bushfire will be managed in accordance with current procedures for the extraction site including maintenance of access roads to provide buffers and provide access for watering or other measures as necessary.

#### **Unmanaged livestock**

The POA will not be utilised for livestock and will be legally protected for conservation under a Voluntary Declaration and covenant



### **Climate Change**

Not applicable to the scope of this project.

### **Genetic Pollutions**

Genetic pollution DNA marker studies have confirmed hybrid genotypes of *Macadamia integrifolia* and *M. ternifolia*, and *M. integrifolia* and *M. tetraphylla* occur within a 20 km overlap zone where both species co-occur within the same rainforest patch (Peace, 2005). This natural predisposition for hybridisation has been found to be causing genetic 'pollution' of wild populations. Both *M. integrifolia* and *M. tetraphylla* are known to occur in the broader locality of the Tamborine region and is identified as an area where hybridisation occurs. The proposed planting specimens will be propagated directly from existing *Macadamia integrifolia* that are proposed to be impacted. Therefore, the offset will mitigate risk of genetic pollution on the area.

### **Disease**

Phytophthora root rot is a major problem for the Australian *Macadamia* industry and is a serious threat to wild populations. Of the Phytophthora species impacting *Macadamia*, *Phytophthora cinnamomi* is most widespread, has frequent impact and is the most devastating. If left untreated, *P. cinnamomi* causes stem canker, root rot, tree decline, dieback and tree death.

With the implementation of standard vehicle washdown and hygiene procedures the risk of disease within the POA is considered minimal.



Table 6: Risk of Failure and Corrective Actions

Action	Completion Criteria	Corrective Action Trigger	Corrective Action
<b>1 – Direct planting</b>	<ul style="list-style-type: none"> <li>A total of 75 plants are sourced via techniques detailed in <b>Section 5.1</b>.</li> <li>Plants specimens achieve &gt;80% survival rate</li> </ul>	<p>The suitable qualified environmental person indicates planting stock not sufficient to meet required numbers.</p> <p>POAR indicates less than 80% survival rate observed through monitoring period detailed in <b>Section 5.2</b></p> <p>POAR identify negative impacts to planted specimens.</p>	<p>Readily available stock of wild <i>Macadamia integrifolia</i> specimens sourced from local nursery.</p> <p>Supplementary planting will be implemented if required within 12 months following corrective action being triggered. Monitoring of infill planting to occur regularly after planting in accordance with watering schedules determined by the suitable qualified environmental person as detailed in <b>Section 5.2.2</b>.</p> <p>Additionally, management actions will be implemented were necessary as determined by the suitably qualified environmental person which includes weed control, erosion control, tree guards, etc.</p> <p>Risk management, corrective actions and adaptive management are to be integrated as required throughout the offset management period in response to changes or natural events.</p> <p>Depending on the above corrective actions, the management period may be extended to ensure environmental outcomes are able to be achieved.</p>

Action	Completion Criteria	Corrective Action Trigger	Corrective Action
<b>2 – Legally secure the offset area</b>	<ul style="list-style-type: none"> <li>• The Planting Offset Area is legally secured for conservation via a Voluntary Declaration (VDEC) process administered under the Queensland <i>Vegetation Management Action 1999</i> prior to the commencement of the action.</li> <li>• Subsequently, the offset area is legally secured in perpetuity within 12 months of the implementation of the IMP via a covenant under the <i>Land Act 1994</i> or <i>Land Titles Act 1994</i> or suitable legal mechanism</li> <li>• The Department is notified of the legal securement via VDEC within 5 business days of commencing the implementation of the IMP <i>i.e.</i>, the date from which the Planting Offset Area is legally secured.</li> <li>• The Department is notified within 5 business days of being legally secured via covenant or similar legal protection mechanism.</li> <li>• The Planting Offset Area is not used for other purposes – site access is restricted.</li> </ul>	Planting Offset Area is not legally secured.	The Planting Offset Area is legally secured prior to any vegetation clearing impacts occur.

### 7.1.2 Limitations

Although an adaptive management plan will be implemented across the Planting Offset Area there remains a number of potential limitations that may arise. These include the following:

- Associated risks and uncertainty in predicting the occurrence and extent of natural disasters or extreme weather events, including drought and flooding.
- Uncertainty of the rate at which planted stock will establish.

To ensure progress towards the environmental outcome and completion criteria, monitoring has been designed to be repeatable and frequent enough to monitor outcomes inline with the completion criteria.

## 8. Conclusion

Saunders Havill has been engaged by Fulton Hogan Quarries Pty Ltd to complete an Impact Management Plan for specimens of *Macadamia integrifolia* (Macadamia Nut) located within the 5.9 ha quarry expansion impact area at Blue Rock Quarry. This IMP is intended to satisfy the EPBC offset requirements (EPBC 2024-09844) and support a *Clearing Permit (protected plants)* to the Department of Environment, Tourism, Science, and Innovation (DETSI) in accordance with the *Nature Conservation (Plants) Regulation 2020 - Protected Plants Assessment Guidelines*.

A total of fifteen (15) *Macadamia integrifolia* (Macadamia Nut) individuals (including juvenile and semi-mature specimens) are proposed to be directly impacted as part of the project. These specimens will be offset in the local area within a 1.77 ha area (POA) of suitable habitat in the north extent of the Fulton Hogan Land holding at a ratio of 4:1. The proposed mitigation planting area and planting procedure including timings and maintenance measures are provided in **Section 5** and **Section 6** of this report.

Under the EPBC act Offset Assessment Guide (OAG) the proposed offset will acquit 300% of the impacted *Macadamia integrifolia* (refer **Appendix C**).

All detailed management measures promote the continued survival of *Macadamia integrifolia* in the local region, both during vegetation clearing and continued operation of the quarry.



## 9. References

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Nagao MA, Hirae HH. *Macadamia: Cultivation and physiology*. *Critical Reviews in Plant Sciences*, (1992); 10(5): 441–470.



# 10. Appendices

## Appendix A

Wildlife Online Search

## Appendix B

Blue Rock Quarry Stormwater Management Plan

## Appendix C

EPBC Offset Assessment Guide (OAG) – *Macadamia integrifolia*



# Appendix A

## *Nature Conservation Act 1992* Wildlife Online Search Results





# Queensland Government

## WildNet species list

Search Criteria: Species List for a Specified Point  
Species: All  
Type: All  
Queensland status: Rare and threatened species  
Records: Confirmed  
Date: Since 1980  
Latitude: -27.8308  
Longitude: 153.1947  
Distance: 5  
Email: liambrzezinski@saundershavill.com  
Date submitted: Tuesday 20 Aug 2024 13:17:20  
Date extracted: Tuesday 20 Aug 2024 13:20:01

The number of records retrieved = 28

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Information about your Species lists request is logged for quality assurance, user support and product enhancement purposes only.

The information provided should be appropriately acknowledged as being derived from WildNet database when it is used. As the WildNet Program is still in a process of collating and vetting data, it is possible the information given is not complete. Go to the WildNet database webpage (<https://www.qld.gov.au/environment/plants-animals/species-information/wildnet>) to find out more about WildNet and where to access other WildNet information products approved for publication. Feedback about WildNet species lists should be emailed to [wildlife.online@des.qld.gov.au](mailto:wildlife.online@des.qld.gov.au).

Kingdom	Class	Family	Scientific Name	Common Name	I	Q	A	Records
animals	amphibians	Limnodynastidae	<i>Adelotus brevis</i>	tusked frog		V		10
animals	birds	Apodidae	<i>Hirundapus caudacutus</i>	white-throated needletail		V	V	1
animals	birds	Cacatuidae	<i>Calyptorhynchus lathami</i>	glossy black-cockatoo		V		1
animals	birds	Cacatuidae	<i>Calyptorhynchus lathami lathami</i>	glossy black-cockatoo (eastern)		V	V	2
animals	birds	Menuridae	<i>Menura alberti</i>	Albert's lyrebird		NT		1
animals	birds	Strigidae	<i>Ninox strenua</i>	powerful owl		V		1
animals	insects	Papilionidae	<i>Ornithoptera richmondia</i>	Richmond birdwing		V		1
animals	mammals	Phascolarctidae	<i>Phascolarctos cinereus</i>	koala		E	E	172
plants	land plants	Apocynaceae	<i>Leichhardtia coronata</i>			V		8/6
plants	land plants	Aristolochiaceae	<i>Pararistolochia praevenosa</i>			NT		2/2
plants	land plants	Asteraceae	<i>Picris conyzoides</i>			V		1/1
plants	land plants	Corynocarpaceae	<i>Corynocarpus rupestris subsp. arborescens</i>	southern corynocarpus		V		3/3
plants	land plants	Ericaceae	<i>Styphelia recurvisepala</i>			E		5/5
plants	land plants	Euphorbiaceae	<i>Baloghia marmorata</i>	jointed baloghia		V	V	2/2
plants	land plants	Euphorbiaceae	<i>Fontainea venosa</i>			V	V	2/2
plants	land plants	Lamiaceae	<i>Coleus habrophyllus</i>			E	E	4/4
plants	land plants	Lauraceae	<i>Cryptocarya foetida</i>	stinking cryptocarya		V	V	2/2
plants	land plants	Lauraceae	<i>Endiandra wongawallanensis</i>			E		8/6
plants	land plants	Leguminosae	<i>Sophora fraseri</i>	brush sophora		V	V	1/1
plants	land plants	Myrtaceae	<i>Gossia hillii</i>			CR		2/2
plants	land plants	Myrtaceae	<i>Rhodamnia dumicola</i>	rib-fruited malletwood		E		2/2
plants	land plants	Oleaceae	<i>Jasminum jenniae</i>			E		1/1
plants	land plants	Proteaceae	<i>Macadamia integrifolia</i>	macadamia nut		V	V	105/10
plants	land plants	Rubiaceae	<i>Randia moorei</i>	spiny gardenia		E	E	13/12
plants	land plants	Sapindaceae	<i>Cupaniopsis newmanii</i>	long-leaved tuckeroo		NT		9
plants	land plants	Sapotaceae	<i>Planchonella eerwah</i>			E	E	3/3
plants	land plants	Sparrmanniaceae	<i>Corchorus cunninghamii</i>			E	E	11/7
plants	land plants	Sterculiaceae	<i>Brachychiton sp. (Ormeau L.H.Bird AQ435851)</i>	Ormeau bottle tree		CR	CE	40/26

#### CODES

I - Y indicates that the taxon is introduced to Queensland and has naturalised.

Q - Indicates the Queensland conservation status of each taxon under the *Nature Conservation Act 1992*.

The codes are Extinct (EX), Extinct in the Wild (PE), Critically Endangered (CR), Endangered (E), Vulnerable (V), Near Threatened (NT), Special Least Concern (SL) and Least Concern (C).

A - Indicates the Australian conservation status of each taxon under the *Environment Protection and Biodiversity Conservation Act 1999*.

The values of EPBC are Extinct (EX), Extinct in the Wild (XW), Critically Endangered (CE), Endangered (E), Vulnerable (V) and Conservation Dependent (CD).

Records - The first number indicates the total number of records of the taxon (wildlife records and species listings for selected areas).

This number is output as 99999 if it equals or exceeds this value. A second number located after a / indicates the number of specimen records for the taxon.

This number is output as 999 if it equals or exceeds this value.

# Appendix B

## Blue Rock Quarry Stormwater Management Plan



# BLUE ROCK QUARRY, CEDAR CREEK

# STORMWATER MANAGEMENT PLAN

Prepared for:  
Fulton Hogan Construction Pty Ltd

Date:  
6 November 2012

File Ref:  
documents / 982\_611\_001\_SMP

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# Document Control

## Job Details

Ref no.:	982_611_001_SMP
Document Title:	Stormwater Management Plan
Principal Author:	Prasanna Rao
Client:	Fulton Hogan Construction Pty Ltd

## Document Status

Version	Description	Date	Author	Reviewer
1	Stormwater Management Plan	6 November 2012	Prasanna Rao	Clayton Hill

## Distribution Record

Destination	# Copies (electronic / hardcopy)								
	V1	V2	V3	V4	V5	V6	V7	V8	V9
Samantha Smith, Fulton Hogan Construction Pty Ltd	1								
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Appendix A	Standard Specification Drawings of Stormwater Management Controls and Devices
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# 1. Introduction

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## 1.1 General

Groundwork Plus has been commissioned by Fulton Hogan Construction Pty Ltd (Fulton Hogan) to prepare a Stormwater Management Plan (SMP) for their extractive industry operations at Blue Rock Quarry on Tamaree Road, Cedar Creek (the subject 'Site'). See Figure 1 – Site Location Plan for the location of the quarry.

This report has been prepared to respond to Item 13 of the Department of Environment and Heritage Protection (EHP) Information Request (dated 8 November 2011) issued in relation to a Material Change of Use (MCU) application (Reference No. MCU201100490). This report will replace the previous SMPs prepared for the quarry which are listed below:

- Stormwater Management Plan, AECOM, 2012;
- Hydrological and Hydraulic Assessment, Golder Associates, 2009; and
- Stormwater Management Plan, Ecoroc Pty Ltd, 2009.

The aim of this SMP is to develop stormwater management strategies that ensure statutory requirements and leading industry practices are achieved.

## 1.2 Scope

It is our understanding that Fulton Hogan is preparing a submission to EHP to demonstrate reporting and approval compliance with the MCU condition requirements. One of the key requirements of the EHP conditions of approval is that the SMP is to achieve one of the following:

- Capture and retain a 24 hour storm event with an average recurrence interval of 1 in 5 years; or
- Achieve a 90% hydraulic efficiency.

The scope of works includes the following processes:

- Review background information including existing site layout plans, stormwater management plans, hydraulic modelling and erosion and sediment control (ESC) plans;
- Review conditions of approval and previous EHP correspondence;
- Attend site inspections and detailed briefing session with Fulton Hogan;
- Prepare a preliminary assessment, concept designs (options) and preliminary recommendations to meet the 1 in 5 year design condition;
- Attend a workshop with Fulton Hogan to determine most feasible option for the SMP including ESC measures;
- Liaise with EHP to ascertain realistic water quality criteria and discuss other key requirements;
- Develop the detailed SMP based on the outcomes of the workshop; and
- Documentation and lodgement of SMP with EHP.

This report provides strategies to control stormwater runoff from disturbed areas of the quarry and prevent or mitigate contamination of stormwater with pollutants such as silts and chemical residues (oils, greases and fuels). The measures proposed are broad-ranging and include processes, procedures and structural controls.

This report sets out to:

- describe the Site and identify possible impacts on the surrounding environment;
- identify legislation, impacts and issues associated with operations;
- set practical and environmentally sound strategies and methods for the design, construction and management of stormwater runoff and erosion and sediment controls;
- describe audit and review processes;
- identify means of assessing whether failures occur; and
- detail actions to be taken if objectives are not met.

Specifically, the SMP details the following:

- Catchment delineation and segregation of disturbed areas of the quarry from the undisturbed areas surrounding the quarry;
- Catchment hydrology and stormwater conveyance;
- Estimation of sediment transport from the disturbed areas of the quarry;
- Operational phase stormwater management and erosion and sediment control measures for the disturbed areas of the quarry;
- Water quality objectives of the receiving waters; and
- Maintenance and Monitoring Program.

To minimise the impact of the development on the external environment, the proponent shall implement this SMP. To avoid significant and/or sustained deterioration in downstream water quality, this SMP shall be amended as required, in response to the Monitoring and Maintenance Program described herein.

### 1.3 Objective

The principal objectives of the SMP are:

- to segregate stormwater catchments with similar uses, levels of disturbance and risk of pollution as undisturbed and disturbed catchments;
- to ensure adequate control measures are implemented to manage runoff from disturbed areas of the existing quarry;
- to implement appropriate measures to eliminate or reduce pollutant and sediment loading in stormwater discharges from disturbed areas of the existing quarry;
- to preserve downstream water quality and ensure water leaving disturbed areas of the existing quarry is not degraded to a significant extent;
- to reduce the potential for erosion on Site and subsequent sedimentation of natural waterways downstream of the quarry;
- to prevent the release of untreated contaminated stormwater from disturbed areas of the existing quarry;
- to provide a framework for the surveillance, response and reporting of incidents which may impact on stormwater quality; and
- to provide a basis for the training of quarry personnel in the management of stormwater and minimise the potential for stormwater contamination.

These objectives will be achieved through the implementation of the following measures:

- Management strategies designed to minimise water pollution from the development;
- Specific operational phase controls to minimise sediment and nutrient export from the subject Site;
- Optimising the volume of stormwater discharged from the quarry having regard to the mass and concentration of contaminants expected to reach the receiving waters;
- Specific operational phase runoff management and diversion controls that can be converted to water harvesting structures with minimal redesign;
- Segregating stormwater by quality or source;
- Reducing contaminant concentrations by the use of appropriate treatment methods; and
- Applying appropriate risk assessment methods in the sizing and design of sediment ponds/dams.

Proposed stormwater runoff management controls for the disturbed areas of the existing quarry will be designed in accordance with the *Queensland Urban Drainage Manual (QUDM)* (EHP, 2008). Proposed erosion and sediment control measures will be designed in accordance with *Book 2 and Book 4 of Best Practice Erosion and Sediment Control* (IECA, 2008).

## 1.4 Site Details

The quarry is situated on Tamaree Road in Cedar Creek, Queensland, approximately 13 km south of Beenleigh. The quarry comprises the following lots:

- Lot 14, 15 and 16 on RP151378;
- Lot 89 on W739; and
- Lot 1 on SP238024.

The quarry is located in a rural setting and has been used for quarrying since 1971. Historically, prior to quarrying, the Site has been used mainly for agricultural purposes, including cattle grazing. The Site is located in a Key Resource Area and is surrounded by rural residential developments. See Figure 1 – Site Location Plan for details.

The quarry is worked using conventional drill and blast open cut quarrying methods and consists of the following principal components or activities:

- Quarry workings;
- Overburden stockpiles;
- Internal haul roads;
- Crushing and screening plant;
- Aggregate and other finished product stockpiles;
- Pre-coat aggregate plant and product storage bays;
- Equipment workshops;
- Office and employee amenity buildings;
- Fuel storage; and
- Water supply dam and stormwater and sediment management controls.

See Figure 2 – Site Layout Plan for details.

## 1.5 Topography and Receiving Environment

The quarry is located in the upper reaches of the Albert River catchment. The receiving water for the Blue Rock Quarry Site is Michie Creek, an ephemeral watercourse which runs parallel to Tamaree Road and joins the Albert River approximately 1.5 km from the quarry entrance and 5 km upstream of the Luscombe Weir. Michie Creek has not been identified as a watercourse and has been designated as a drainage feature, as determined by EHP.

Current quarrying and related activities extend over 40 ha within the Site and have significantly altered over time, the topography, vegetation and drainage of the area. Steep upper slopes beyond the limit of quarry workings support regrowth vegetation and some woodland. Site levels vary from approximately RL 280 m AHD along the Site's north-eastern boundary to approximately RL 45 m AHD near the Site's entrance along the north-western boundary.

## 1.6 Environmental Values

In accordance with the Environmental Protection (Water) Policy 2009, EPP (Water), environmental values for the Lower Albert River (estuarine) including tributaries have been identified to include:

- Aquatic ecosystems wildlife habitat;
- Irrigation, stockwater and farm use;
- Primary, secondary and visual recreation;
- Cultural heritage;
- Industrial use; and
- Aquaculture.

The following Water Quality Objectives have been considered in the development of the SMP for the quarry:

- pH – 6.5 to 8.0;
- Dissolved Oxygen – 80% to 105% saturation;
- Turbidity – 50 NTU;
- Suspended Solids or correlated turbidity vs. suspended solids – 50 mg/L;
- Total Phosphorous – 0.07 mg/L;
- Total Nitrogen – 0.65 mg/L;
- Litter/gross pollutants – No man made material greater than 5 mm; and
- Oil/grease – no visible films or odours.

These Water Quality Objectives are based on the Queensland Water Quality Guidelines (EHP, 2009) and ANZECC Guidelines (NWQMS, 2000). The Queensland Water Quality Guidelines specify a water quality objective of 6 mg/L for suspended solids for Lowland Streams in South East Queensland (SEQ); however, the water quality objective of 50 mg/L has been specified for the site since this is considered to be typical of background values in the SEQ region.

## 2. Catchment Delineation and Hydrological Analysis

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### 2.1 Catchment Delineation

Based on existing topography, the Site has been divided into thirteen (13) catchments. The Site catchment areas are presented in Table 1 – Site Catchment Areas.

Table 1 – Site Catchment Areas

Catchment	Catchment Type	Catchment Area (ha)
A	Disturbed	6.7
B	Disturbed	6.4
C	Disturbed	3.1
D	Disturbed	10.2
E	Disturbed	7.3
F	Undisturbed	4.7
G	Disturbed	1.9
H	Undisturbed	8.8
I	Undisturbed	23.9
J	Undisturbed	67.9
K	Undisturbed	25.1
L	Undisturbed	15.5
M	Undisturbed	11.1

Catchments A to E and G mainly comprise the working areas, haul roads, stockpile areas, processing, treatment, administrative and office areas of the quarry. These areas have been cleared of vegetation in the past and have been progressively developed, resulting in the generation of sediment laden runoff during storm events. As such, these areas have been classified to be disturbed areas.

Catchments F and H to M mainly comprise dense bushland and rehabilitated areas of the quarry. These have been classified as clean undisturbed areas.

Horton's 'n' value of 0.02 has been assumed for disturbed catchment areas (Catchments A to E and G), in accordance with QUDM. Horton's 'n' values ranging between 0.055 and 0.06 have been assumed for undisturbed catchments (Catchments F and H to M). These values have been used to calculate the Time of Concentration ( $t_c$ ) and peak flow rates for all events up to and including the  $Q_{100}$  storm event, using the Rational Method in accordance with QUDM.

The times of concentration, peak flow rates and peak runoff volumes for each catchment are summarised in subsequent sections of this report.

Refer Figure 3 – Catchment Delineation Plan for the catchment areas.

### 2.2 Catchment Hydrology

#### 2.2.1 Intensity – Frequency – Duration

Rainfall intensities for various storm durations are shown in Table 2 – Rainfall Intensities for Various Storm Durations, Blue Rock Quarry.

Table 2 – Rainfall Intensities for Various Storm Durations, Blue Rock Quarry

Duration of Rainfall	Average Recurrence Interval (1:n years)						
	1	2	5	10	20	50	100
5 mins	120	152	187	206	234	269	296
6 mins	113	143	175	194	220	253	278
10 mins	92.2	117	144	159	181	208	230
20 mins	67.6	85.9	106	118	134	154	170
30 mins	55.1	70.1	86.8	96.4	110	127	140
1 hour	37.2	47.5	59.1	65.8	75	87	96.2
2 hours	23.9	30.5	38.2	42.7	48.7	56.7	62.8
3 hours	18.2	23.2	29.1	32.6	37.3	43.4	48.2
6 hours	11.3	14.5	18.3	20.5	23.5	27.4	30.5
12 hours	7.18	9.23	11.7	13.2	15.2	17.8	19.9
24 hours	4.75	6.14	7.91	8.97	10.4	12.3	13.7
48 hours	3.17	4.12	5.41	6.18	7.21	8.59	9.67
72 hours	2.4	3.13	4.15	4.77	5.59	6.7	7.56

NB: All rainfall intensities in mm/hr.

### 2.2.2 Runoff Calculations

The peak runoff generated by the catchments of the quarry for various design storm events has been estimated using the following equation in accordance with *Book 2 – Appendices A-G, Best Practice Erosion and Sediment Control (International Erosion Control Association, 2008)*.

$$V = (Cv.R.A)/1000$$

where:

V = Runoff volume (m<sup>3</sup>)

Cv = Volumetric runoff coefficient

A = Area (hectares)

R = Total rainfall (mm)

The 24 hour storm intensities and peak runoff volumes for storm events for Catchments A to M are summarised in Table 3 – Peak Runoff Volumes below. A volumetric runoff co-efficient of 0.83 has been assumed for the Site. This assumption has been made for the peak 24 hours 1 in 5 year design rainfall depth of 189.8 mm in accordance with Table B7 of Book 2 of the IECA Guidelines.

Table 3 – Peak Runoff Volumes

Catchment	Description	Catchment Area (ha)	24 hr Rainfall Intensity (mm/hr)	24 hr Rainfall Depth (mm)	Runoff Volume (m <sup>3</sup> )
A	1 in 1, 24 hour	6.7	4.75	114.0	6,340
	1 in 2, 24 hour		6.14	147.4	8,195
	1 in 5, 24 hour		7.91	189.8	10,557
	1 in 10, 24 hour		8.97	215.3	11,972
	1 in 20, 24 hour		10.4	249.6	13,880
	1 in 50, 24 hour		12.3	295.2	16,416
	1 in 100, 24 hour		13.7	328.8	18,285
B	1 in 1, 24 hour	6.4	4.75	114.0	6,056
	1 in 2, 24 hour		6.14	147.4	7,828
	1 in 5, 24 hour		7.91	189.8	10,084
	1 in 10, 24 hour		8.97	215.3	11,436
	1 in 20, 24 hour		10.4	249.6	13,259
	1 in 50, 24 hour		12.3	295.2	15,681
	1 in 100, 24 hour		13.7	328.8	17,466

Catchment	Description	Catchment Area (ha)	24 hr Rainfall Intensity (mm/hr)	24 hr Rainfall Depth (mm)	Runoff Volume (m <sup>3</sup> )
C	1 in 1, 24 hour	3.1	4.75	114.0	2,933
	1 in 2, 24 hour		6.14	147.4	3,792
	1 in 5, 24 hour		7.91	189.8	4,885
	1 in 10, 24 hour		8.97	215.3	5,539
	1 in 20, 24 hour		10.4	249.6	6,422
	1 in 50, 24 hour		12.3	295.2	7,595
	1 in 100, 24 hour		13.7	328.8	8,460
D	1 in 1, 24 hour	10.2	4.75	114.0	9,613
	1 in 2, 24 hour		6.14	147.4	12,427
	1 in 5, 24 hour		7.91	189.8	16,009
	1 in 10, 24 hour		8.97	215.3	18,154
	1 in 20, 24 hour		10.4	249.6	21,048
	1 in 50, 24 hour		12.3	295.2	24,894
	1 in 100, 24 hour		13.7	328.8	27,727
E	1 in 1, 24 hour	7.3	4.75	114.0	6,945
	1 in 2, 24 hour		6.14	147.4	8,977
	1 in 5, 24 hour		7.91	189.8	11,565
	1 in 10, 24 hour		8.97	215.3	13,115
	1 in 20, 24 hour		10.4	249.6	15,206
	1 in 50, 24 hour		12.3	295.2	17,984
	1 in 100, 24 hour		13.7	328.8	20,031
F	1 in 1, 24 hour	4.7	4.75	114.0	4,447
	1 in 2, 24 hour		6.14	147.4	5,749
	1 in 5, 24 hour		7.91	189.8	7,406
	1 in 10, 24 hour		8.97	215.3	8,398
	1 in 20, 24 hour		10.4	249.6	9,737
	1 in 50, 24 hour		12.3	295.2	11,516
	1 in 100, 24 hour		13.7	328.8	12,826
G	1 in 1, 24 hour	1.9	4.75	114.0	1,748
	1 in 2, 24 hour		6.14	147.4	2,259
	1 in 5, 24 hour		7.91	189.8	2,910
	1 in 10, 24 hour		8.97	215.3	3,300
	1 in 20, 24 hour		10.4	249.6	3,826
	1 in 50, 24 hour		12.3	295.2	4,525
	1 in 100, 24 hour		13.7	328.8	5,041
H	1 in 1, 24 hour	8.8	4.75	114.0	8,336
	1 in 2, 24 hour		6.14	147.4	10,775
	1 in 5, 24 hour		7.91	189.8	13,882
	1 in 10, 24 hour		8.97	215.3	15,742
	1 in 20, 24 hour		10.4	249.6	18,252
	1 in 50, 24 hour		12.3	295.2	21,586
	1 in 100, 24 hour		13.7	328.8	24,043
I	1 in 1, 24 hour	23.9	4.75	114.0	22,586
	1 in 2, 24 hour		6.14	147.4	29,195
	1 in 5, 24 hour		7.91	189.8	37,611
	1 in 10, 24 hour		8.97	215.3	42,651
	1 in 20, 24 hour		10.4	249.6	49,451
	1 in 50, 24 hour		12.3	295.2	58,485
	1 in 100, 24 hour		13.7	328.8	65,142
J	1 in 1, 24 hour	67.9	4.75	114.0	64,304

Catchment	Description	Catchment Area (ha)	24 hr Rainfall Intensity (mm/hr)	24 hr Rainfall Depth (mm)	Runoff Volume (m <sup>3</sup> )
	1 in 2, 24 hour		6.14	147.4	83,121
	1 in 5, 24 hour		7.91	189.8	107,083
	1 in 10, 24 hour		8.97	215.3	121,433
	1 in 20, 24 hour		10.4	249.6	140,791
	1 in 50, 24 hour		12.3	295.2	166,513
	1 in 100, 24 hour		13.7	328.8	185,466
K	1 in 1, 24 hour	25.1	4.75	114.0	23,759
	1 in 2, 24 hour		6.14	147.4	30,712
	1 in 5, 24 hour		7.91	189.8	39,565
	1 in 10, 24 hour		8.97	215.3	44,867
	1 in 20, 24 hour		10.4	249.6	52,020
	1 in 50, 24 hour		12.3	295.2	61,524
	1 in 100, 24 hour		13.7	328.8	68,526
L	1 in 1, 24 hour	15.5	4.75	114.0	14,628
	1 in 2, 24 hour		6.14	147.4	18,909
	1 in 5, 24 hour		7.91	189.8	24,360
	1 in 10, 24 hour		8.97	215.3	27,624
	1 in 20, 24 hour		10.4	249.6	32,028
	1 in 50, 24 hour		12.3	295.2	37,879
	1 in 100, 24 hour		13.7	328.8	42,191
M	1 in 1, 24 hour	11.1	4.75	114.0	10,456
	1 in 2, 24 hour		6.14	147.4	13,515
	1 in 5, 24 hour		7.91	189.8	17,411
	1 in 10, 24 hour		8.97	215.3	19,744
	1 in 20, 24 hour		10.4	249.6	22,892
	1 in 50, 24 hour		12.3	295.2	27,074
	1 in 100, 24 hour		13.7	328.8	30,156

### 2.2.3 Time of Concentration and Rational Method Calculations

The natural hydrology of the quarry and its catchments has been assessed in accordance with QUDM and Gold Coast City Council Planning Scheme 2003 Policy 11 – Land Development Guidelines. The quarry catchments have been considered to be predominantly piped or channelized urban catchments less than 500 ha with the top of the catchment being bushland or grassed park.

The time of concentration for all catchments has been determined using Friend's Equation as per QUDM Table 4.06.3, combined with a channel time flow calculation. Friend's Equation is defined as follows:

#### Friend's Equation

$$t_c = (107 \times n \times L^{0.333}) / S^{0.2}$$

where

$t_c$  = overland sheet flow travel time (minutes)

$L$  = overland sheet flow path length (m)

$n$  = Horton's surface roughness factor (-)

$S$  = slope of surface (%)

Table 4 – Time of Concentration presents a summary of catchment parameters used within Friend's Equation and the calculated time of concentration for the existing scenario.

Table 4 – Time of Concentration

Catchment	A	B	C	D	E	F	G	H	I	J	K	L	M
<b>Overland Flow Component</b>													
Estimated L length of sheet flow (m)	50	50	20	200	100	20	100	20	20	200	200	200	20
Horton's Roughness Value	0.02	0.02	0.02	0.02	0.02	0.055	0.02	0.05	0.05	0.06	0.06	0.06	0.06
Slope (%)	12.3	10.9	13.9	11	9	15.4	4.4	31.8	29	9	30.2	30.3	28.1
$t_c$ (minutes)	4.77	4.88	3.43	7.73	6.39	9.24	7.37	7.26	7.40	20.13	18.96	18.94	8.93
<b>Channel/Creek Flow Component</b>													
Length of Channel Flow (m)	480	640	160	1070	472	370	125	420	563	1804	760	675	490
Velocity (m/s) – assume 1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
$t_c$ (minutes)	5.33	7.11	1.78	11.89	5.24	4.11	1.39	4.67	6.26	20.04	8.44	7.50	5.44
TOTAL $t_c$	10.1	12.0	5.2	19.6	11.6	13.4	8.8	12.0	13.7	40.2	27.4	26.4	14.4

Design storm events across the catchments were derived using the Rational Method as per QUDM. This involved:

- Determination of a  $C_{10}$  value (derived in accordance with Table 3.5A of the GCCC Land Development Guidelines). A  $C_{10}$  value of 0.95 has been applied to Catchments A to E, while a  $C_{10}$  value of 0.75 has been applied to Catchments F to L;
- Derivation of design rainfall using BoM Intensity Frequency Duration (IFD) data for the Blue Rock Quarry; and
- Calculation of design flows through the catchments for the  $Q_{100}$ ,  $Q_{50}$ ,  $Q_{20}$ ,  $Q_{10}$ ,  $Q_5$ ,  $Q_2$  and  $Q_{3\text{month}}$  rainfall events where  $Q_{3\text{month}}$  is deemed to be 50% of the  $Q_1$  rainfall event.

A summary of the hydrologic calculations are presented in Table 5 – Catchment Hydrology below.

Table 5 – Catchment Hydrology

Catchment	Area	t <sub>c</sub>	I <sub>100</sub>	C	Q <sub>100</sub>	I <sub>50</sub>	C	Q <sub>50</sub>	I <sub>20</sub>	C	Q <sub>20</sub>	I <sub>10</sub>	C	Q <sub>10</sub>	I <sub>5</sub>	C	Q <sub>5</sub>	I <sub>2</sub>	C	Q <sub>2</sub>	I <sub>1</sub>	C	Q <sub>3month</sub>
ID	(ha)	(min)	(mm/hr)		(m <sup>3</sup> /s)	(mm/hr)		(m <sup>3</sup> /s)	(mm/hr)		(m <sup>3</sup> /s)	(mm/hr)		(m <sup>3</sup> /s)	(mm/hr)		(m <sup>3</sup> /s)	(mm/hr)		(m <sup>3</sup> /s)	(mm/hr)		(m <sup>3</sup> /s)
A	6.7	10.10	229.40	1.00	4.27	207.46	1.00	3.86	180.53	1.00	3.35	158.59	0.95	2.80	143.62	0.90	2.41	116.69	0.81	1.75	91.95	0.76	0.65
B	6.4	11.99	218.00	1.00	3.88	197.20	1.00	3.51	171.60	1.00	3.04	150.80	0.95	2.55	136.40	0.90	2.19	110.78	0.81	1.59	87.28	0.76	0.59
C	3.1	5.21	210.20	1.00	1.81	265.80	1.00	2.29	231.20	1.00	1.99	203.60	0.95	1.67	184.60	0.90	1.43	150.20	0.81	1.04	118.60	0.76	0.39
D	10.2	19.62	172.40	1.00	4.87	156.16	1.00	4.41	135.88	1.00	3.83	119.64	0.95	3.21	107.52	0.90	2.74	87.14	0.81	1.99	68.58	0.76	0.74
E	7.3	11.64	220.40	1.00	4.49	199.36	1.00	4.06	173.48	1.00	3.53	152.44	0.95	2.95	137.92	0.90	2.54	112.02	0.81	1.84	88.26	0.76	0.68
F	4.7	13.35	210.20	0.90	2.47	190.18	0.86	2.14	165.49	0.79	1.70	145.47	0.75	1.42	131.46	0.71	1.22	106.74	0.64	0.89	84.08	0.60	0.33
G	1.9	8.76	244.40	1.00	1.25	221.50	1.00	1.14	192.70	1.00	0.99	169.50	0.95	0.83	153.30	0.90	0.71	124.80	0.81	0.52	98.44	0.76	0.19
H	8.8	11.93	218.60	0.90	4.81	197.74	0.86	4.17	172.07	0.79	3.32	151.21	0.75	2.78	136.78	0.71	2.38	111.09	0.64	1.73	87.53	0.60	0.64
I	23.9	13.65	207.80	0.90	12.40	188.02	0.86	10.75	163.61	0.79	8.54	143.83	0.75	7.15	129.94	0.71	6.14	105.49	0.64	4.46	83.10	0.60	1.65
J	67.9	40.17	125.11	0.90	21.26	113.40	0.86	18.46	98.10	0.79	14.58	86.00	0.75	12.18	77.38	0.71	10.41	62.42	0.64	7.51	49.01	0.60	2.78
K	25.1	27.40	147.80	0.90	9.28	134.02	0.86	8.06	116.24	0.79	6.38	102.02	0.75	5.34	91.79	0.71	4.56	74.21	0.64	3.30	58.35	0.60	1.22
L	15.5	26.44	150.80	0.90	5.83	136.72	0.86	5.06	118.64	0.79	4.01	104.18	0.75	3.36	93.71	0.71	2.87	75.79	0.64	2.07	59.60	0.60	0.77
M	11.1	14.38	203.60	0.90	5.62	184.24	0.86	4.88	160.32	0.79	3.88	140.96	0.75	3.25	127.28	0.71	2.78	103.32	0.64	2.02	81.38	0.60	0.75

The selection and assessment of appropriate best management practices required to address erosion and sediment runoff from the quarry catchments are presented in the following sections. All proposed stormwater conveyance structures on Site have been designed using the Q<sub>10</sub> peak flow rate summarised in Table 5. Catch drains and drainage channels have been designed to convey the Q<sub>10</sub> peak flow rate. Flows from upstream undisturbed areas are proposed to be diverted to Michie Creek through an appropriately sized stormwater pipe network to be located near the stockpile area and has been sized to convey the peak Q<sub>10</sub> flow rate.

Catchments F and H to M have been designated as undisturbed areas and therefore, in accordance with best practice, no treatment has been proposed for these areas.

## 3. Stormwater Management Strategy

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### 3.1 Principles of Stormwater Management

The following is a summary of the principles which are the basis of this SMP:

- The SMP will be reviewed periodically and will be updated as necessary to include revised quarry development layout, topographic plans and development plans, control device designs, specifications and design parameters;
- Drainage systems and flow control devices are designed to control stormwater for a design Average Recurrence Interval (ARI) of 10 years. Designs are based on calculated water discharge rates and velocities;
- Wherever practicable, clean water will be diverted around the site and into drainage structures and watercourses in a non-erosive manner;
- Existing catch drains, diversion drains and pipes are used to the maximum practicable extent;
- Land disturbance will be minimised to the maximum practicable extent;
- Ground cover will be maximised through agronomic soil testing, amelioration and the use of suitable plant selection;
- Sediment treatment structures will be sized according to the requirements and where this is not practicable, their performance will be improved through the use of chemical flocculation;
- Proposed stormwater drainage controls and structures (catch drains, check dams, diversion drains, diversion bunds, sediment basins, sumps etc.) will be installed as soon as practicable;
- Proposed diversion drains, drainage channels and catch drains will be riprapped and/or grass lined unless otherwise stated. Drains will be excavated to twice the design depth and backfilled with coarse rock materials to the design depth;
- Rock check dams will be constructed at regular intervals in accordance with the IECA Guidelines within all existing and proposed catch drains, including roadside drains along haul roads;
- Any mobile equipment used on Site will be restricted to designated roads or hardstand areas;
- A monitoring program will be undertaken to program maintenance and assess the effectiveness of erosion and sediment control methods and devices;
- Stormwater treatment systems comprising sediment ponds will be constructed to remove sediment. Monitoring and maintenance of the stormwater treatment systems will ensure that sediment trapping capacity remains effective; and
- Water collected in the sediment treatment and storage devices will be recycled to the maximum practicable extent. This water will be available for dust suppression, processing and/or the irrigation of rehabilitated areas.

### 3.2 Proposed Stormwater Management Strategies

Conceptual stormwater management strategies and controls for the quarry are shown on Figure 4 – Stormwater Management Controls while sectional details of these controls and structures have been presented on Figure 5 – Stormwater Management Details. These specific stormwater management measures and controls have been developed in accordance with QUDM and the IECA guidelines for Catchments A to E and Catchment G only as part of this assessment. Catchments F and H to M are undisturbed catchments and therefore have been excluded from this assessment.

Standard specification drawings of stormwater management controls and measures have been prepared in accordance with the IECA Guidelines and are included in Appendix A.

#### 3.2.1 Sizing of Existing and Proposed Catch Drains

Existing and proposed catch drains have been sized using Channel Flow Equations 4.08 and 4.09 from QUDM Section 4.06.10. The catch drains are proposed to be rock lined/riprapped to assist in the removal of sediment and reduce velocity of peak flow.

Rock check dams will be constructed within all existing and proposed catch drains on the quarry Site in accordance with the IECA Guidelines. The construction of these catch drains is expected to help reduce the velocity of flow within the catch drains and reduce scouring at the receiving end.

Details of catch drains are summarised in Table 6 below.

Table 6 – Catch Drain Sizing Calculations

Catch Drain ID	Lining Type	Manning's (n)	Grade (S)	Base Width (m)	Batter Slope	Depth (m)	Velocity (m/s)	Peak Flow Conveyance Capacity (m <sup>3</sup> /s)	Depth and Velocity Product (D*V)
CD1	Rock lined/rip rap	0.02	0.02	1.0	1 in 4	0.25	2.1	1.1	0.5
CD2	Rock lined/rip rap	0.02	0.11	2.5	1 in 4	0.25	4.8	3.2	1.2
CD3	Rock lined/rip rap	0.02	0.13	2.5	1 in 4	0.2	5.2	3.4	1.0
CD4	Rock lined/rip rap	0.02	0.12	2.0	1 in 4	0.2	5.0	2.8	1.0
CD5	Rock lined/rip rap	0.02	0.03	0.5	1 in 4	0.25	2.2	0.8	0.5

Refer Figure 4 – Stormwater Management Controls for the location of catch drains CD1 to CD5.

### 3.2.2 Sizing of Proposed Sumps

The proposed sumps in Catchments A, B and C have been designed to capture and treat the 24 hour, 1 in 5 year rainfall runoff. The location of these sumps is shown on Figure 4 – Stormwater Management Controls.

Table 7 below summarises the volume and dimensions of the proposed sumps including batter requirements.

Table 7 – Sump Sizing Calculations

Sediment Basin ID	Catchment ID	Design Rainfall event	Volumetric Runoff Coefficient	Design Rainfall Depth (mm)	Sediment Settling Volume (m <sup>3</sup> )	Sediment Storage Volume (m <sup>3</sup> )	Total Volume (m <sup>3</sup> )	Depth (m)	Batter Slope/Angle	Area (m <sup>2</sup> )
A	A	24 hour, 1 in 5 years	0.83	189.8	10,557	5,278	15,835	7	80°	2,262
B	B				10,084	5,042	15,126	5	80°	3,025
C	C				4,884	2,442	7,326	5	80°	1,465

Due to the limited space available in the working area for establishing the proposed sumps, the volume of holding capacity of Sumps A, B and C have been restricted to 11 ML, 13 ML and 5 ML holding capacity respectively. The remainder of the runoff from the design storm event will be contained within the drop cut where Sump C is located. This will result in the flooding of the working area during the design rainfall periods. The extent of flooding within this drop cut is shown on Figure 4 – Stormwater Management Controls and the average depth of flooding has been calculated to be 1.54 m.

### 3.2.3 Sizing of Proposed Sediment Basins

Sediment basins are required on Site to treat dirty runoff from disturbed catchments D, E and G of the quarry. The proposed sediment basins have been designed as Type F basins in accordance with the IECA Guidelines. The following formula from the IECA Guidelines has been used to calculate the settling and sediment storage volumes of proposed sediment basins on Site. The sediment storage volume has been assumed to be 50% of the settling volume in accordance with the IECA Guidelines.

$$V_{set} = 10.C_v.A.R_{y\%ile, x\text{-days}}$$

where:

$V_{set}$  = Settling Volume (m<sup>3</sup>)

$V_{stor}$  = Sediment storage Volume (m<sup>3</sup>)

$C_v$  = the volumetric runoff coefficient (dimensionless)

A = Area (hectares)

$R_{y\%ile, x\text{-days}}$  = Design rainfall event (mm)

The sediment basins have been designed to treat peak runoff generated by the 24 hour, 1 in 5 year storm event. The design rainfall depth from the 24 hour, 1 in 5 year storm event has been calculated to be 189.8 mm for the Blue Rock Quarry. The sediment basin calculations are summarised in Table 8 below.

Table 8 – Sediment Basin Sizing Calculations

Sediment Basin ID	Catchment ID	Design Rainfall event	Volumetric Runoff Coefficient	Design Rainfall Depth (mm)	Sediment Settling Volume (m <sup>3</sup> )	Sediment Storage Volume (m <sup>3</sup> )	Total Volume (m <sup>3</sup> )	Depth (m)	Batter Slope/Angle	Area (m <sup>2</sup> )
D	D	24 hour, 1 in 5 years	0.83	189.8	16,008	8,004	24,012	6	1:1/45°	4,830
E	E				11,565	5,782	17,347	6	1:1/45°	3,598
G	G				2,910	1,455	4,365	4	1:1/45°	1,381

Refer Figure 4 – Stormwater Management Controls for the location of the proposed sediment basins.

### 3.2.4 Emergency Spillway Calculations

Emergency spillways for the proposed sediment basins have been designed to convey any flows in excess of the Q5 flow rate to the downstream receiving environment. The location of the spillways is shown on Figure 4 – Stormwater Management Controls. The spillway calculations are summarised in Table 9 below.

Table 9 – Emergency Spillway Sizing Calculations

Sediment Basin/SUMP ID	Catchment	Design ARI	Time of concentration (minutes)	Intensity (mm)	Co-efficient of Runoff	Discharge Rate (m <sup>3</sup> /s)	Bottom Width of Spillway (m)	Depth of water over weir (m)	Freeboard over water level to Crest (m)
Sump B	B	50	12.0	197.2	1.00	3.5	8	0.36	0.39
Sediment Basin D	D	50	19.6	156.16	1.00	4.5	10	0.37	0.38
Sediment Basin E	E	50	11.6	199.36	1.00	4.2	9	0.38	0.37
Sediment Basin G	G	50	8.8	221.5	1.00	1.4	3.5	0.34	0.41

### 3.2.5 Diversion of Clean Flows from Upstream Undisturbed Catchments to Michie Creek

The stormwater pipe infrastructure at the entrance to the Site will need to be upgraded to divert flows from upstream undisturbed catchments. The current infrastructure includes a 375 mm diameter pipe which is currently conveying flows from Catchment H (refer Figure 3 – Catchment Delineation Plan). A secondary 525 mm diameter pipe currently discharges flows from Catchment J (refer Figure 3 – Catchment Delineation Plan) to the existing ephemeral wetland area. The existing 375 mm diameter pipe and 525 mm diameter pipe have been found to be grossly undersized to convey the Q<sub>10</sub> flow rate from the upstream catchments and hence will need to be upgraded to convey the peak Q<sub>10</sub> flow rate. An overland flow path will be provided to convey flows in excess of Q<sub>10</sub> to the Site's legal point of discharge.

Preliminary calculations have indicated that, in order to convey the peak Q<sub>10</sub> flow rate from Catchment H, the existing 375 mm diameter pipe will need to be replaced with twin 525 mm diameter pipes with the construction of a head wall to prevent scouring and buoyancy during peak flow conditions. An end wall will be constructed at the downstream end of the twin 525 mm diameter pipes and outlet scour protection will be provided to aid in energy dissipation.

The existing 525 mm diameter pipe will be retained in its original location, in addition, twin 1,500 mm diameter pipes will be constructed upstream of the existing 525 mm diameter pipe to convey flows from Catchment J to the wetland area. In order to dissipate energy, a stormwater pit with a surface area of 130 m<sup>2</sup> and depth of 2.5 m will be constructed at the upstream end of the twin 1,500 mm diameter pipes. Baffles with low flow orifices will be constructed within the pit which will help dissipate energy and reduce velocity of flow within the proposed pipes and at the outlet. An end wall and scour protection will be provided at the downstream end of the pipes to further aid in energy dissipation and the reduction of velocity at the outlet. In addition, rock check dams may also be constructed within the diversion channel at regular intervals in accordance with the IECA Guidelines.

Refer Figure 4 – Stormwater Management Controls and Figure 5 – Stormwater Management Details for details of the proposed measures.

### *3.2.6 Rehabilitation/Revegetation of Exposed Areas of the Quarry*

Certain areas of the upper reaches of the quarry are currently bare and exposed to the elements resulting in the transport of sediment laden runoff to the clean water diversion drain during periods of rainfall. These areas (refer Figure 4 – Stormwater Management Controls) will be progressively revegetated by grass seeding using a suitable grass species. Mulch berms/sediment fences will be installed along the edge of the proposed rehabilitation area and maintained with the aim of maximising ground cover through soil remediation and the use of suitable vegetation.

Stormwater runoff from these areas will be diverted to the existing clean water diversion channel by the construction of a catch drain and diversion bund along the edge of the rehabilitated areas. Refer Figure 4 – Stormwater Management Controls for the location of the diversion structures.

### *3.2.7 Stabilisation and Rehabilitation of Exposed Stockpile Embankments in the Upper Reaches of the Quarry*

The steep embankments of the stockpile areas abutting the clean water diversion channel in the upper reaches of the quarry currently pose a high erodibility risk and subsequent contamination of the clean water diversion channel. In order to stabilise these stockpile embankments and prevent the runoff of sediment laden water into the clean water diversion channel, it is proposed that these slopes be stabilised via soil rendering with the use of suitable soil conditioning agents/chemicals. In addition, geofabric material will be installed over these slopes and sediment fencing erected at the base of these banks until the slopes have been stabilised and vegetative cover has been established.

Refer Figure 4 – Stormwater Management Controls for details.

### *3.2.8 Maintenance of the Existing Ephemeral Wetland Area*

A man made ephemeral wetland area is present downstream of the existing sediment basin in the lower part of the quarry, adjacent to the existing stockpile area. This wetland area will need to be reconstructed in order to provide for the final treatment of stormwater discharged from the Site. Fine sediments and nutrients will be removed from the pre-treated stormwater in the wetland area via sedimentation, fine filtration and biological uptake. The vegetated wetland area, over time, will also provide habitat and improved landscape amenity.

Refer Figure 4 – Stormwater Management Controls for the location and footprint of the wetland area.

### *3.2.9 Treatment of Sediment Laden Stormwater and Feasibility of an Automatic Flocculation System*

Water and soil sampling and analysis will be required to determine the soil characteristics and particle size distribution in order to select the most appropriate flocculating chemical/agent to be used on Site. The use of flocculants and/or coagulants is likely to significantly improve the quality of water discharging from the site. Flocculants/coagulants should be applied to the sediment basins immediately following a rain event in appropriate doses as recommended by the manufacturer.

The feasibility of using an automatic flocculation system on Site was investigated as part of this assessment. Preliminary investigations of a rainfall activated Desiltation Unit manufactured by LandLoch Pty Ltd has revealed that the use of such a system or similar on Site will help reduce the volume and footprint of the required sediment basins for the design storm event by approximately 50% while achieving water quality objectives at the same time. Further investigations including a comparative analysis will be required during the detailed design stage and formal discussions and approvals from EHP will be required before using such a system on Site.

## 4. Maintenance and Monitoring

---

### 4.1 Maintenance

Stormwater conveyance and treatment infrastructure such as catch drains, sediment basins and wetlands require inspection and maintenance to ensure they operate in accordance with the design intent. Maintenance of these systems will typically involve:

- Routine inspection to identify damage to vegetation, scouring or litter and sediment build up;
- Routine inspection of inlet and outlet points to identify any areas of scour, blockages and sediment build up;
- Removal and management of invasive weeds;
- Periodic desilting of sediment basins and conveyance structures including sediment fences; and
- Vegetation pest monitoring and control.

### 4.2 Monitoring

The following Water Quality Objectives have been considered in the development of the SMP for the quarry:

- pH – 6.5 to 8.0;
- Dissolved Oxygen – 80% to 105% saturation;
- Turbidity – 50 NTU;
- Suspended Solids or correlated turbidity vs. suspended solids – 50 mg/L;
- Total Phosphorous – 0.07 mg/L;
- Total Nitrogen – 0.65 mg/L;
- Litter/gross pollutants – No man made material greater than 5 mm; and
- Oil/grease – no visible films or odours.

Water quality monitoring will need to be undertaken to ensure that the proposed management controls are working. Fulton Hogan currently undertakes periodic water quality monitoring and the results of monitoring are reported annually to EHP.

Water quality monitoring undertaken on Site should meet the water quality objectives listed above in addition to the water quality objectives of receiving waters and/or any other requirements set by the conditions of approval by EHP. As a minimum, water quality monitoring should be undertaken immediately following a storm event and during events of discharge from Sediment Basins D, E and G at the legal points of discharge from the site as specified in the environmental authority.

## 5. Conclusion

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This study has investigated potential impacts of the existing extractive industry activities of Blue Rock Quarry on downstream receiving watercourses. Based on this study, the following conclusions have been drawn:

- Stormwater and sediment management controls and measures have been developed for the disturbed areas of the quarry.
- The proposed sediment basins have been designed to capture and retain a 24 hour storm event with an average recurrence interval of 1 in 5 years in accordance with Item 13 of the Department of Environment and Heritage Protection (EHP) Information Request (dated 8 November 2011).
- Runoff from the upstream undisturbed areas is diverted to Michie Creek, around the disturbed areas of the quarry.
- The sediment basins have been designed to capture and treat the runoff from a 24 hour, 1 in 5 year storm event.
- Preliminary investigations have revealed that the use of such a rainfall activated desiltation unit or similar on Site will help reduce the volume and footprint of the required sediment basins for the design storm event by approximately 50% while achieving water quality objectives at the same time.

In summary, the integrity of receiving water bodies will not be adversely impacted as a result of the ongoing activities on Site provided the mitigation measures described herein are implemented and maintained.

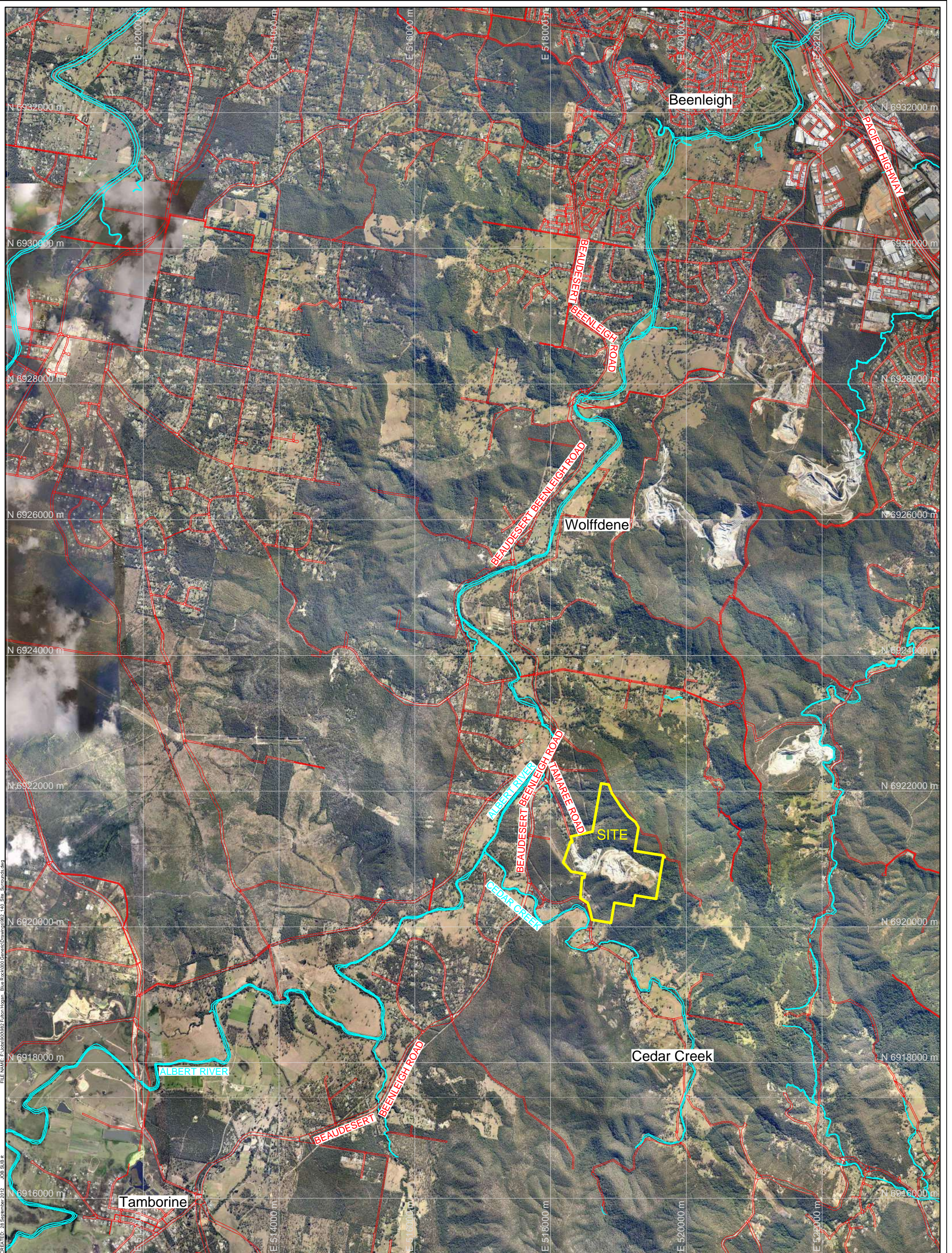
## 6. Reference

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The information presented herein has been prepared with reference to the following:

- Stormwater Management Plan, Ecoroc Pty Ltd, December 2009.
- Hydrological and Hydraulic Assessment, Golder Associates, November 2009.
- Queensland Urban Drainage Manual, Department of Environment and Heritage Protection, 2008.
- Stormwater Management Plan, AECOM, August 2012.
- Environmental Protection Policy (Water), Department of Environment and Heritage Protection, 2010.
- Urban Stormwater Quality Planning Guidelines 2010, Department of Environment and Heritage Protection, 2010.
- Monitoring and Sampling Manual, 2009. Department of Environment and Heritage Protection, 2009.

fi gures




REV	DESCRIPTION	DATE	BY

Data Sources:  
 Photography: Nearmap, Image date: 2012-08-05  
 Topography: Cadastre  
 Ecosystem: Other

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**Legend:**


- Site Boundary
- Cadastral Boundary - Road
- Cadastral Boundary - Watercourse

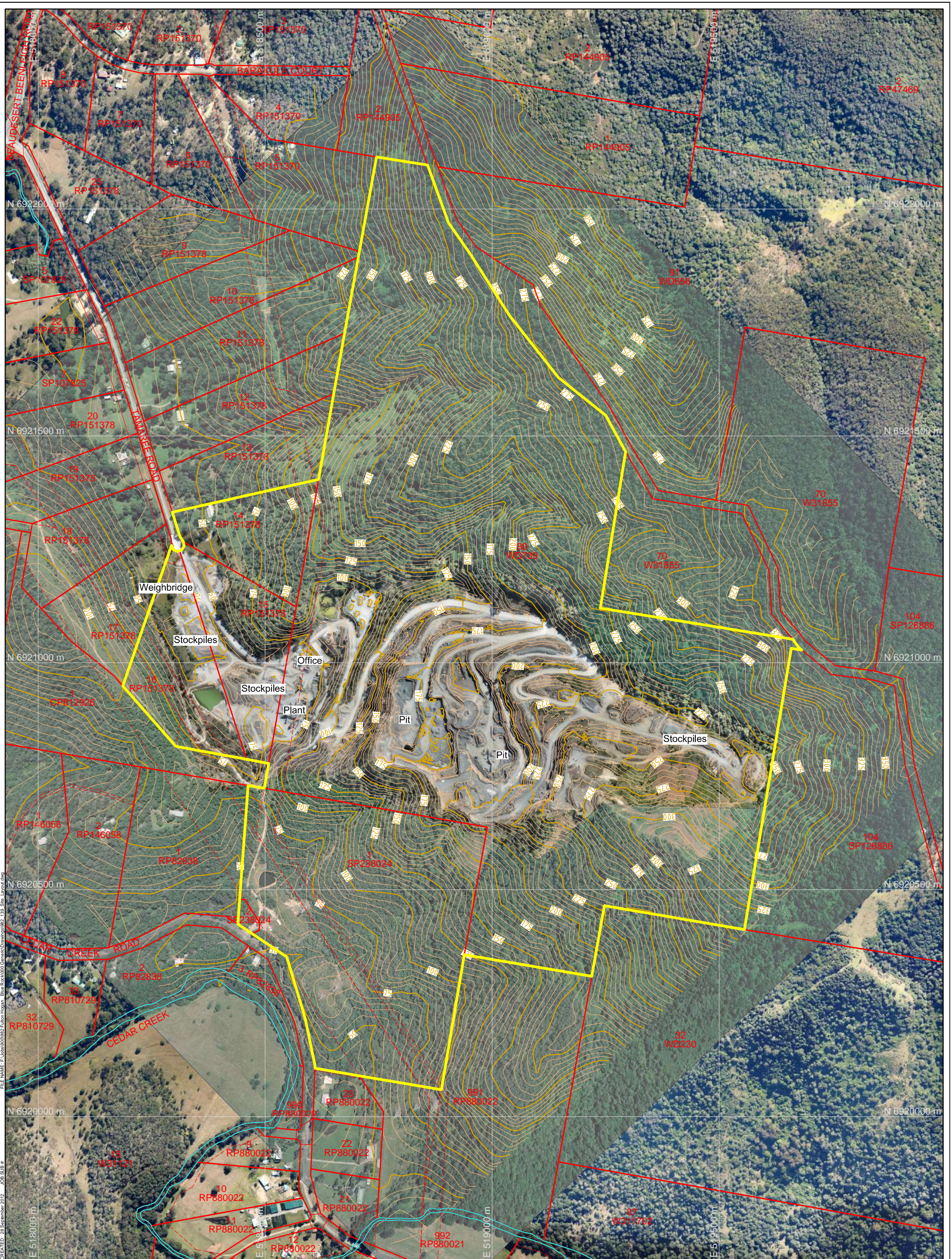


PROJECT: **Blue Rock Quarry**

CLIENT: **Fulton Hogan**

TITLE: **Figure 1 - Site Location Plan**


 SCALE: 1:50,000  
 0 1km  
 DRAWING NUMBER: **982.140** REVISION:   
 DATE: 28 September 2012 DRAWN: LT DATUM: HORIZONTAL / VERTICAL / ZONE  
 PRINTED: 28 September 2012 CHECKED: MGA / / 56




REV	DESCRIPTION	DATE	BY

**Data Sources:**  
 Photography: Fulton Hogan, 2012-09-03; Vektia 2011-03-23; Nearmap 2012-08-05  
 Topography: Fulton Hogan, 2012-09-03; Vektia 2011-03-23  
 Cadastral: Ecosystem:  
 Other:

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**Legend:**

- Site Boundary
- Cadastral Boundary
- - - Easement Boundary

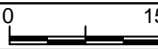


PROJECT: **Blue Rock Quarry**

CLIENT: **Fulton Hogan**

TITLE: **Figure 2 - Site Layout Plan**

SCALE: 1:7,500

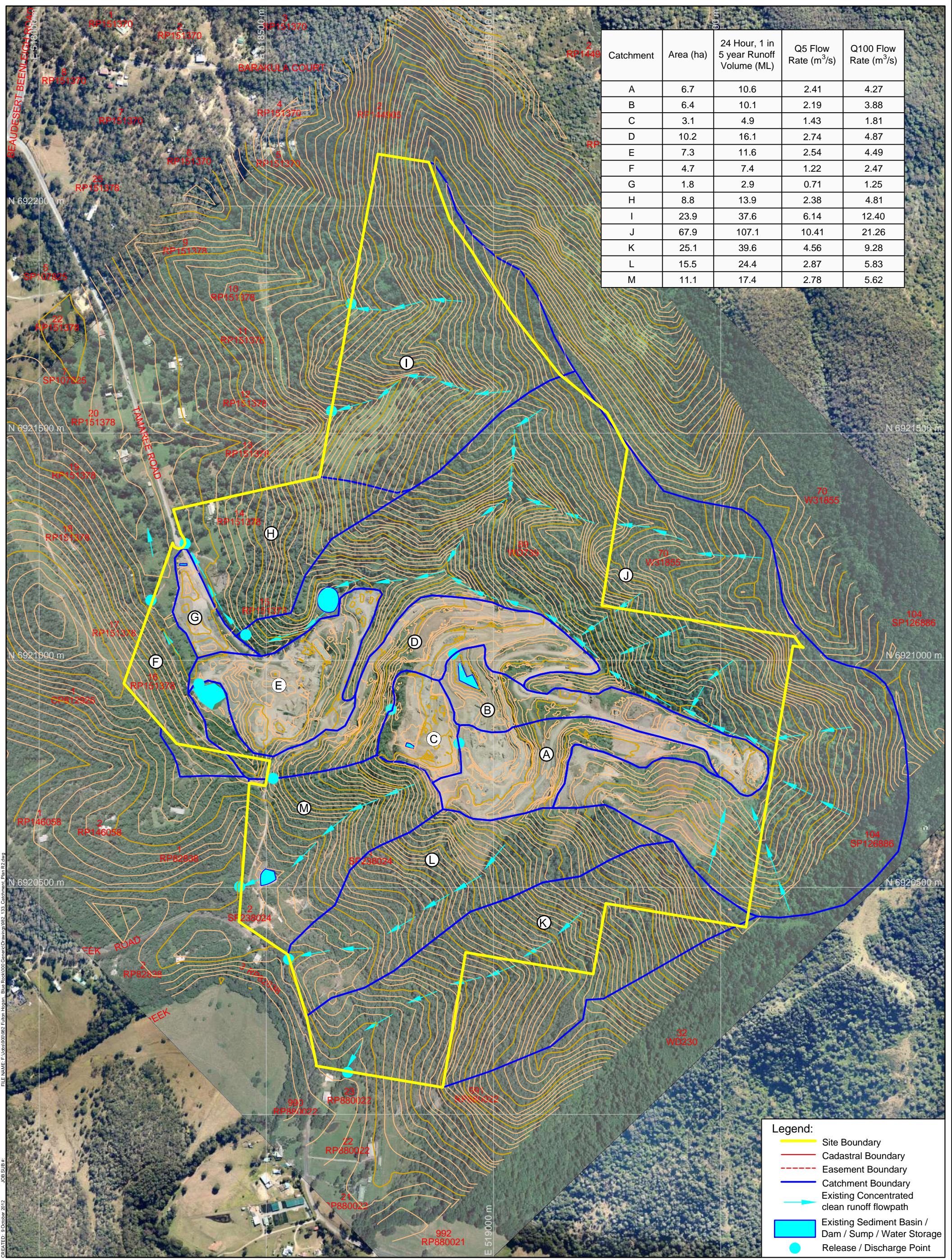


DATE: 28 September 2012  
 PRINTED: 28 September 2012

DRAWING NUMBER: **982.139**

REVISION: **LT**

DATUM: HORIZONTAL / VERTICAL / ZONE  
 MGA / AHD / 56



Catchment	Area (ha)	24 Hour, 1 in 5 year Runoff Volume (ML)	Q5 Flow Rate (m <sup>3</sup> /s)	Q100 Flow Rate (m <sup>3</sup> /s)
A	6.7	10.6	2.41	4.27
B	6.4	10.1	2.19	3.88
C	3.1	4.9	1.43	1.81
D	10.2	16.1	2.74	4.87
E	7.3	11.6	2.54	4.49
F	4.7	7.4	1.22	2.47
G	1.8	2.9	0.71	1.25
H	8.8	13.9	2.38	4.81
I	23.9	37.6	6.14	12.40
J	67.9	107.1	10.41	21.26
K	25.1	39.6	4.56	9.28
L	15.5	24.4	2.87	5.83
M	11.1	17.4	2.78	5.62

**Legend:**

- Site Boundary
- Cadastral Boundary
- - - Easement Boundary
- Catchment Boundary
- Existing Concentrated clean runoff flowpath
- Existing Sediment Basin / Dam / Sump / Water Storage
- Release / Discharge Point

REV	DESCRIPTION	DATE	BY
1	Catchment Delineation Plan	27/8/12	LT
2	Amendments to Catchment Areas	30/10/12	LT/PR

**Data Sources:**  
 Photography: Fulton Hogan, 2012-09-03; Vekta 2011-03-23; Nearmap 2012-08-05  
 Topography: Fulton Hogan, 2012-09-03; Vekta 2011-03-23  
 Cadastral: Other  
 Ecosystem: Other

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PROJECT: **Blue Rock Quarry**

CLIENT: **Fulton Hogan**

TITLE: **Figure 3 - Catchment Delineation Plan**

SCALE: 1:7,500

DATE: 5 November 2012

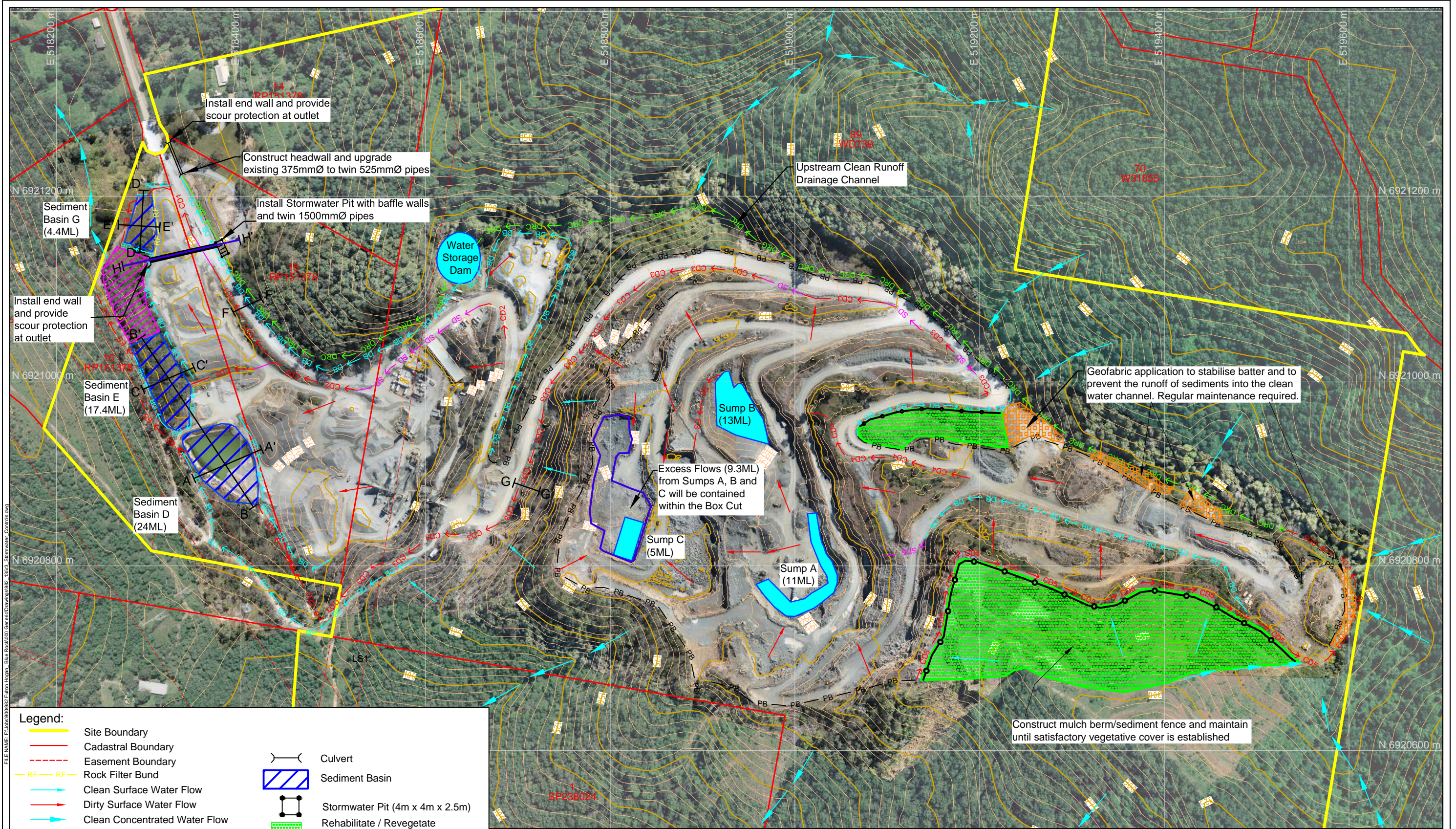
PRINTED: 5 November 2012

DRAWING NUMBER: **982.133**

REVISION: **2**

DATUM: HORIZONTAL / VERTICAL / ZONE  
MGA / AHD / 56

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**Legend:**

- Site Boundary
- Cadastral Boundary
- - - Easement Boundary
- RF — Rock Filter Bund
- Clean Surface Water Flow
- Dirty Surface Water Flow
- Clean Concentrated Water Flow
- DB → Diversion Bund - Clean Water
- CD → Catch Drain - Dirty Water
- DRC → Drainage Channel
- SD → Spoon Drain
- PB — Perimeter Bund
- RF — Rock Filter Bund
- ES → Emergency Spillway
- Mulch Berm
- Culvert
- Sediment Basin
- Stormwater Pit (4m x 4m x 2.5m)
- Rehabilitate / Revegetate by grass seeding
- Existing Ephemeral Wetland area
- Geofabric Application for Batter Stabilisation
- Q5 Flood Inundation Area (Depth =1.54m)
- A—A' Cross Section (refer Drg 982.137)
- Water storage and Sumps

- Notes:**
- Sediment basins D, E and G have been designed as Type F basins in accordance with the IECA (2008) guidelines.
  - Sediment basins have been designed to treat the runoff generated by the 24 hours, 1 in 5 year storm event.
  - Construct rock check dams, in accordance with the IECA Guidelines, within all conveyance structures including catch drains. Rock check dams are to be constructed at 50m intervals except in steep sections where the maximum separation distance between rock check dams should be 25m.
  - Vegetate using a suitable grass species, the batters of all existing and proposed diversion structures including diversion bunds, perimeter bunds, and the batters of all sediment basins.
  - Refer Figure 5 - Stormwater Management Details for sectional details and dimensions of stormwater management structures.

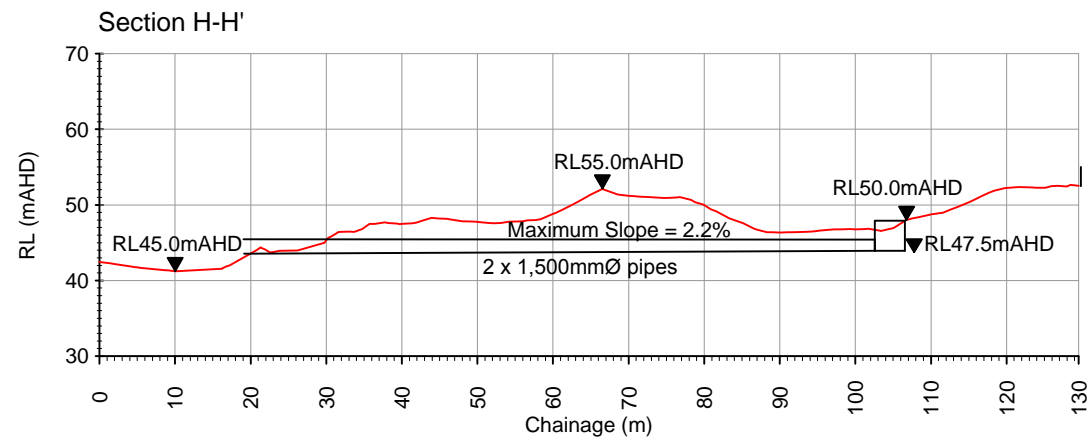
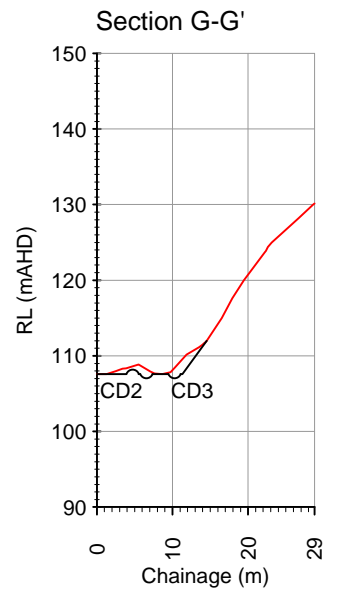
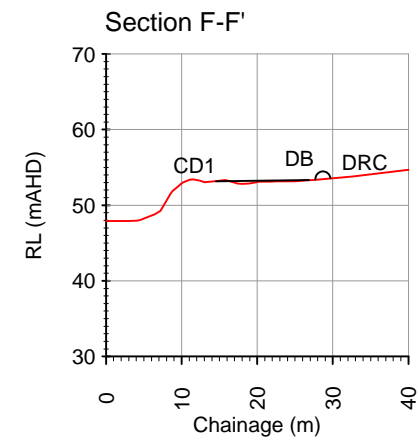
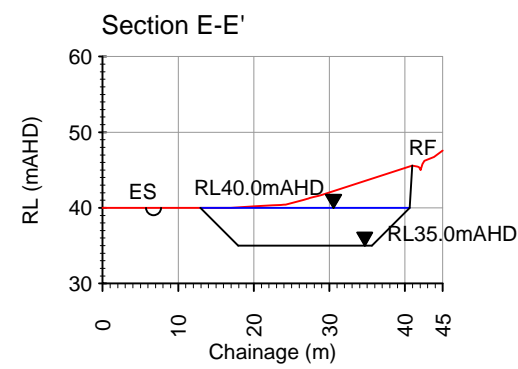
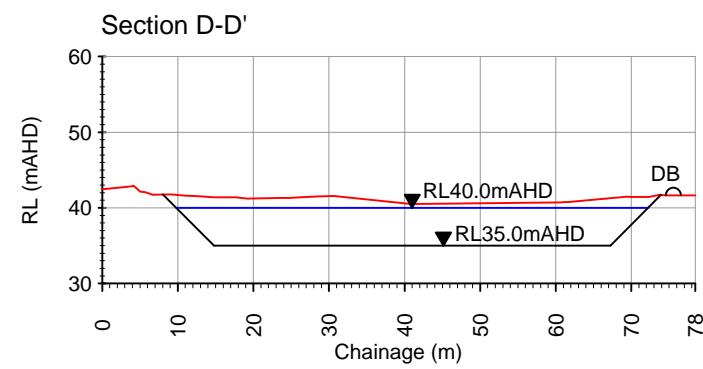
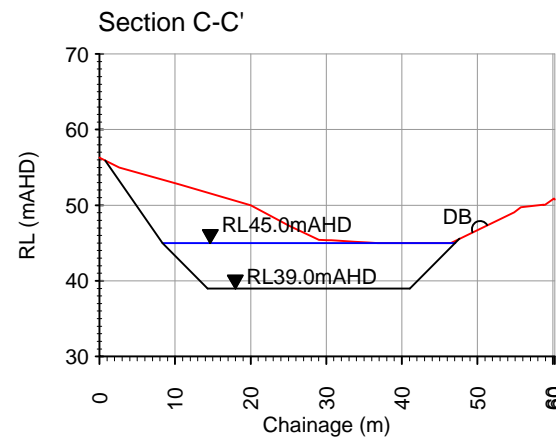
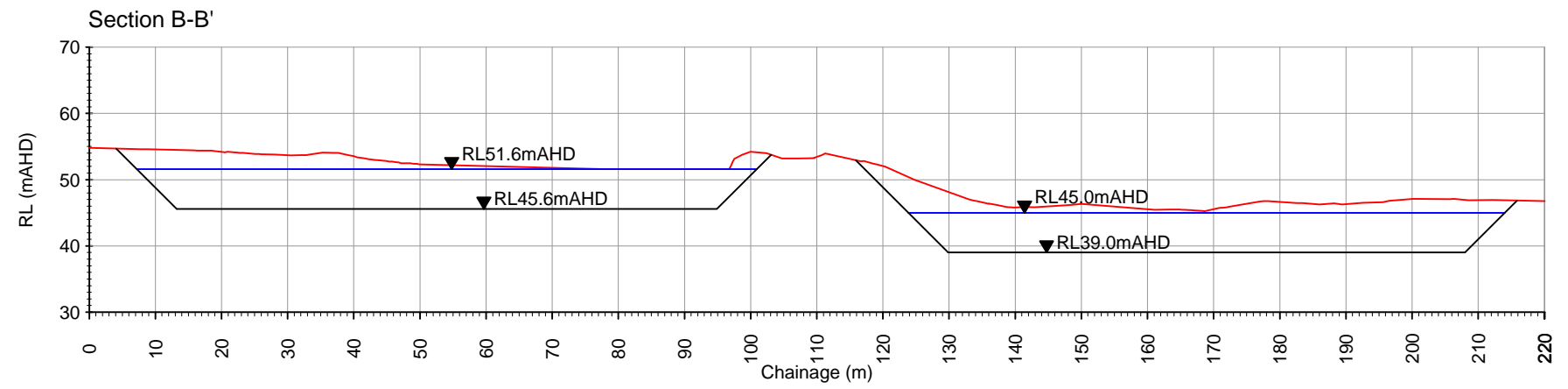
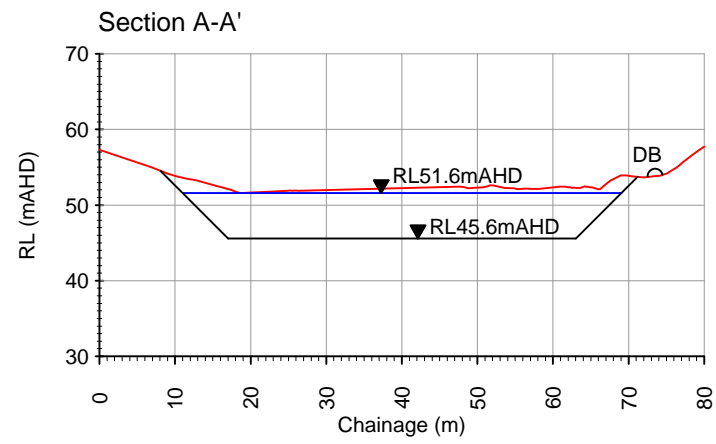
REV	DESCRIPTION	DATE	BY
1	Updated design	8/10/12	PR
2	Updated design and Q5 flood level	30/10/12	LT/PR
3	Text and presentation changes	05/11/12	MH

**Data Sources:**  
 Photography: Fulton Hogan, 2012-09-03; Vekta 2011-03-23  
 Topography: Fulton Hogan, 2012-09-03; Vekta 2011-03-23  
 Cadastre: Other:  
 Ecosystem: Other:

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PROJECT: <b>Blue Rock Quarry</b>	TITLE: <b>Figure 4 - Stormwater Management Controls</b>
CLIENT: <b>Fulton Hogan</b>	GROUNDWORK plus SCALE: 1:4,000 DATE: 6 November 2012 PRINTED: 6 November 2012
DRAWING NUMBER: <b>982.135</b>	REVISION: <b>3</b>
DATUM: HORIZONTAL / VERTICAL / ZONE MGA / AHD / 56	



Sediment Basin Sizing				
Basin ID	Catchment	Surface Area (m <sup>2</sup> )	Depth (m)	Volume (ML)
D	D	4,830	6	24.1
E	E	3,600	6	17.4
G	G	1,380	4	4.4

Emergency Spillway Calculations						
Sediment Basin / Sump ID	Sub-catchment	Design ARI	Discharge rate (m <sup>3</sup> /s)	Bottom width of spillway (m)	Depth of water over weir (m)	Freeboard over water level to crest (m)
Sump B	B	50	3.5	8	0.36	0.39
Sediment Basin D	D	50	4.5	10	0.37	0.38
Sediment Basin E	E	50	4.2	9	0.38	0.37
Sediment Basin G	G	50	1.4	3.5	0.34	0.41

Catch Drain Calculations								
Channel ID	Channel Type	Manning n	Grade S	Base Width (m)	Depth (m)	Velocity (m/s)	Flow (m <sup>3</sup> /s)	Depth & Velocity Product
CD1	Rock lined/Rip Rapped	0.02	0.02	1.0	0.25	2.1	1.1	0.5
CD2	Rock lined/Rip Rapped	0.02	0.11	2.5	0.25	4.8	3.2	1.2
CD3	Rock lined/Rip Rapped	0.02	0.13	2.5	0.2	5.2	3.4	1.0
CD4	Rock lined/Rip Rapped	0.02	0.12	2.0	0.2	5.0	2.8	1.0
CD5	Rock lined/Rip Rapped	0.02	0.03	0.5	0.25	2.2	0.8	0.5

FILE NAME: F:\Jobs\982137\Fulton Hogan - Blue Rock Quarry - Stormwater - details.dwg

REV	DESCRIPTION	DATE	BY

Data Sources:  
 Photography: Fulton Hogan, 2012-09-03; Vekta 2011-03-23  
 Cadastre:  
 Ecosystem:  
 Other:

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**Legend:**

- Existing Ground
- Proposed Finished Level
- Sediment Basin



<b>Blue Rock Quarry</b>  <b>Fulton Hogan</b>	<b>Figure 5 - Stormwater Management Details</b>
	SCALE: 1:1,000 
CLIENT:	DRAWING NUMBER: <b>982.137</b> REVISION: <b>2</b>
PH: +61 7 3871 0411 WWW.GROUNDWORK.COM.AU	DATE: 1 November 2012 PRINTED: 1 November 2012 DRAWN: LT CHECKED:

DATUM: HORIZONTAL / VERTICAL / ZONE  
 MGA / AHD / 56

appendices

# Appendix A

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Standard Specification Drawings of Stormwater Management Controls and Devices

# Catch Drain - Grass Lined CD

→ CD →

## **Installation**

1. Ensure all necessary soil testing (e.g. soil pH, nutrient levels) and analysis has been completed, and required soil adjustments performed prior to planting.
2. Clear the location for the catch drain, clearing only what is needed to provide access for personnel and equipment for installation.
3. Remove roots, stumps, and other debris and dispose of them properly. Do not use debris to build the bank.
4. Grade the drain to the specified slope and form the associated embankment with compacted fill. Note that the drain invert must fall 10cm every 10m for each 1% of channel gradient.
5. Ensure the sides of the cut drain are no steeper than a 1.5:1 (H:V) slope and the embankment fill slopes no steeper than 2:1.
6. Ensure the completed drain has sufficient deep (as specified for the type of drain) measured from the drain invert to the top of the embankment. Where necessary, cut the drain slightly deeper such that the correct channel dimensions are achieved following placement of the turf.
7. Ensure the drain has a constant fall in the desired direction free of obstructions.
8. Turf should be used within 12-hours of delivery, otherwise ensure the turf is stored in conditions appropriate for the weather conditions (e.g. a shaded area).
9. Moistening the turf after it is unrolled will help maintain its viability.
10. Turf should be laid on a minimum 75mm bed of adequately fertilised topsoil. Rake the soil surface to break the crust just before laying the turf.
11. During the warmer months, lightly irrigate the soil immediately before laying the turf.
12. Ensure the turf is not laid on gravel, heavily compacted soils, or soils that have been recently treated with herbicides.
13. For wide drains and high velocity chutes, lay the first row of turf in a straight line diagonal to the direction of flow. Stagger subsequent rows in a brick-like (stretcher bond) pattern. The turf should not be stretched or overlapped. Use a knife or sharp spade to trim and fit irregularly shaped areas.
14. For narrow drains, lay the turf along the direction of the drain, ensuring, wherever practicable, that a longitudinal joint between two strips of turf is not positioned along the invert of the drain.
15. Ensure the turf extends up the sides of the drain at least 100mm above the elevation of the channel invert, or at least to a sufficient elevation to fully contain expected channel flow.
16. On channel gradients of 3:1(H:V) or steeper, or in situations where high flow velocities (i.e. velocity >1.5m/s) are likely within the first 2-weeks following placement, secure the individual turf strips with wooden or plastic pegs.
17. Ensure that intimate contact is achieved and maintained between the turf and the soil such that seepage flow beneath the turf is avoided.
18. Water until the soil is wet 100mm below the turf. Thereafter, watering should be sufficient to maintain and promote healthy growth.
19. Ensure the drain discharges to a stable outlet such that down-slope soil erosion will be prevented from occurring. Ensure the drain does not discharge to an unstable fill slope.

## **Maintenance**

1. Inspect all catch drains at least weekly and after runoff-producing storm events and repair any slumps, bank damage, or loss of freeboard.
2. Ensure fill material or sediment is not partially blocking the drain. Where necessary, remove any deposited material to allow free drainage.
3. Dispose of any sediment or fill in a manner that will not create an erosion or pollution hazard.

## **Removal**

1. When the soil disturbance above the catch drain is finished and the area is stabilised, the drain and any associated banks should be removed, unless it is to remain as a permanent drainage feature.
2. Dispose of any sediment or earth in a manner that will not create an erosion or pollution hazard.
3. Grade the area and smooth it out in preparation for stabilisation.
4. Stabilise the area by grassing or as specified within the approved plan.

FILE NAME: P:\Admin\AurCAD\Templates\SWMP\_AurCAD-CD-3\_Catch\_Drain - Grass Lined.dwg  
12 October 2011  
PRINTED: 12 October 2011

Reference: Witheridge 2010, *Erosion and Sediment Control - A field Guide for Construction Site Managers*. Catchments & Creeks Pty Ltd., Brisbane, Queensland

# Catch Drain - Rock Lined CD

→ CD →

## Materials

### Rock:

- \* All rock must be hard, weather resistant, and durable against disintegration under conditions to be met in handling, placement and operation.
- \* All rock must have its greatest dimension not greater than 3 times its least dimensions.
- \* The rock used in formation of the drain must be evenly graded with 50% by weight larger than the specified nominal rock size and have sufficient small rock to fill the voids between the larger rock. Dirt, fines, and smaller rock must not exceed 5% by weight.
- \* The diameter of the largest rock size should be no larger than 1.5 times the nominal rock size. Specific gravity to be at least 2.5.

### Filter cloth:

- \* Geotextile fabric: heavy-duty, needle-punched, non-woven filter cloth, minimum 'bidim' A24 or equivalent.

## Installation

1. Prior to placement, all rocks must be visually checked for size, elongation, cracks, deterioration and other visible defects. The degree and thoroughness of such checking must be appropriate for the potential consequences associated with failure of the structure or purpose for which the material will be used.
2. Clear the location for the catch drain, clearing only what is needed to provide access for personnel and equipment for installation.
3. Remove roots, stumps, and other debris and dispose of them properly. Do not use debris to build the bank.
4. Remove all soft, yielding material; replace with suitable on-site material; compact to smooth firm surface.
5. Excavate the drain to the lines and grades shown on the approved plans. Over-cut the drain to a depth equal to the specified depth of rock placement such that the finished top surface will be at the elevation of the surrounding land. Placement of the rock lining must not reduce the drain's top width and depth as specified within the approved plans.
6. Grade the drain to the specified slope and form the associated embankment with compacted fill. Note that the drain invert must fall 10cm every 10m for each 1% of channel gradient.
7. Ensure the sides of the cut drain are no steeper than a 1.5:1 (H:V) slope and the embankment fill slopes no steeper than 2:1.
8. If the drain is cut into a dispersive (sodic) soil, then prior to placing filter cloth, the exposed dispersive soil must be covered with a minimum 200mm thick layer of non-dispersive soil prior to placement of filter cloth or rocks.
9. If a filter cloth underlay is specified, place the filter fabric directly on the prepared foundation. If more than one sheet of filter cloth is required to cover the area, overlap the edge of each sheet at least 300mm, and secure anchor pins at minimum 1m spacing along the overlap.
10. Ensure the filter cloth is protected from punching or tearing during installation of the fabric and the rock. Repair any damage by removing the rock and placing with another piece of filter cloth over the damaged area overlapping the existing fabric a minimum of 300mm.
11. Placement of rock should follow immediately after placement of the filter layer. Place rock so that it forms a dense, well-graded mass of rock with a minimum of voids.
12. Place rock lining to the extent and depth indicated within the approved plans.
13. Ensure the rock is placed in an appropriate manner to avoid displacing underlying materials or placing undue impact force on the bedding materials.
14. Ensure the rock is placed with a minimum thickness of 1.5 times the nominal rock size (d50).
15. Ensure materials that are d50 and larger are positioned flush with the top surface with faces and shapes matched to minimise voids.
16. Ensure projections above or depressions under the specified top surface are less than 20% of the rock layer thickness. The average surface plane of the finished rock is defined as the plane where 50% of the tops of rocks would contact.
17. Ensure the completed drain has sufficient depth (as specified for the type of drain) measured from the drain invert (average surface plane along channel invert) to the top of the embankment. The average surface plane of the finished rock is defined as the plane where 50% of the tops of rocks would contact.
18. To the maximum degree practicable, the material between larger rock must not be loose or easily displaced by the expected flow.
19. After placement of the rock lining, ensure the drain has a constant fall in the desired direction free of obstructions.
20. Ensure the drain discharges to a stable outlet such that soil erosion will be prevented from occurring. Ensure the drain does not discharge to an unstable fill slope.

## Maintenance

1. Inspect all catch drains at least weekly and after runoff-producing storm events and repair any slumps, bank damage, or loss of freeboard.
2. Closely inspect the outer edges of the rock protection. Ensure water entry into the rock-lined area is not causing erosion along the edge of the rock protection.
3. Carefully check the stability of the rock looking for indications of piping, scour holes, or bank failures.
4. Replace or reposition the surface rock such that the drain functions as required and the drain's required hydraulic capacity is not reduced.
5. Replace any displaced rock with rock of a significantly (minimum 110%) larger size than the displaced rock.
6. Ensure sediment is not partially blocking the drain. Where necessary, remove any deposited material to allow free drainage.
7. Dispose of any sediment or fill in a manner that will not create an erosion or pollution hazard.

## Removal

1. When the soil disturbance above the catch drain is finished and the area is stabilised, the drain and any associated banks should be removed, unless it is to remain as a permanent drainage feature.
2. Dispose of any sediment or earth in a manner that will not create an erosion or pollution hazard.
3. Grade the area and smooth it out in preparation for stabilisation.
4. Stabilise the area by grassing.

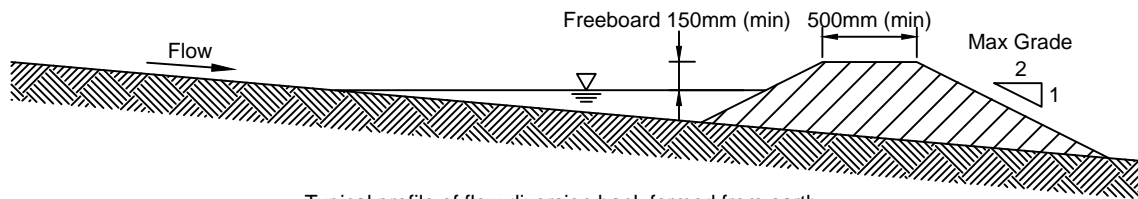
Reference: Witheridge 2010, *Erosion and Sediment Control - A field Guide for Construction Site Managers*. Catchments & Creeks Pty Ltd., Brisbane, Queensland

FILE NAME: F:\Admin\AurCAD\Templates\SWMP\_Aurplus-CD-5\_Catch Drain - Rock Lined.dwg  
PRINTED: 13 October 2011  
CREATED: 12 October 2011

## Flow Diversion Bank / Perimeter Bund DB / PB

→ DB →

→ PB →



Typical profile of flow diversion bank formed from earth

### Installation

1. Clear the location for the bank, clearing only the area that is needed to provide access for personnel and equipment.
2. Remove roots, stumps, and other debris and dispose of them properly. Do not use debris to build the bank.
3. Form the bank from the topsoil and overburden material from the extraction area.
4. If earth is used, then ensure the sides of the bank are no steeper than a 2:1 (H:V) slope, and the completed bank must be at least 500mm high.
5. Check the bank alignment to ensure positive drainage in the desired direction.
6. The bank should be vegetated (turfed, seeded and mulched), or otherwise stabilised immediately, unless it will operate for less than 30 days or if significant rainfall is not expected during the life of the bank.
7. Ensure the embankment drains to a stable outlet, and does not discharge to an unstable slope.

### Maintenance

1. Inspect flow diversion banks at least weekly and after runoff-producing rainfall.
2. Inspect the bank for any slumps, wheel track damage or loss of freeboard. Make repairs as necessary.
3. Check that fill material or sediment has not partially blocked the drainage path up-slope of the embankment. Where necessary, remove any deposited material to allow free drainage.
4. Dispose of any collected sediment or fill in a manner that will not create an erosion or pollution hazard.
5. Repair any places in the bank that are weakened or in risk of failure.

### Removal

1. When the soil disturbance above the bank is finished and the area is stabilised, the flow diversion bank should be removed, unless it is to remain as a permanent drainage feature.
2. Dispose of any sediment or earth in a manner that will not create an erosion or pollution hazard.
3. Grade the area and smooth it out in preparation for stabilisation.
4. Stabilise the area by grassing or as specified in the approved plan.

### Recommended dimensions of flow diversion banks

Parameter	Earth Banks	Vegetated Banks
Height (min)	500mm	500mm
Top Width (min)	500mm	500mm
Base Width (min)	2500mm	2500mm
Side Slope (max)	2:1 (H:V)	2:1 (H:V)
Freeboard	300mm	150mm

## Diversion Channel DC

→ DC →

### Installation

1. Ensure all necessary soil testing (e.g. soil pH, nutrient levels) and analysis has been completed, and required soil adjustments performed prior to planting.
2. Clear the location for the channel, clearing only what is needed to provide access for personnel and construction equipment.
3. Remove roots, stumps, and other debris and dispose of them properly. Do not use debris to build any associated embankments.
4. Excavate the diversion channel to the specified shape, elevation and gradient. The sides of the channel should be no steeper than a 2:1 (H:V) if constructed in earth, unless specifically directed within the approved plans.
5. Stabilise the channel and banks immediately unless it will operate for less than 30 days. In either case, temporary erosion protection (matting, rock, etc.) will be required as specified within the approved plans or as directed.
6. Ensure the channel discharges to a stable area.

### Additional requirements for turf placement:

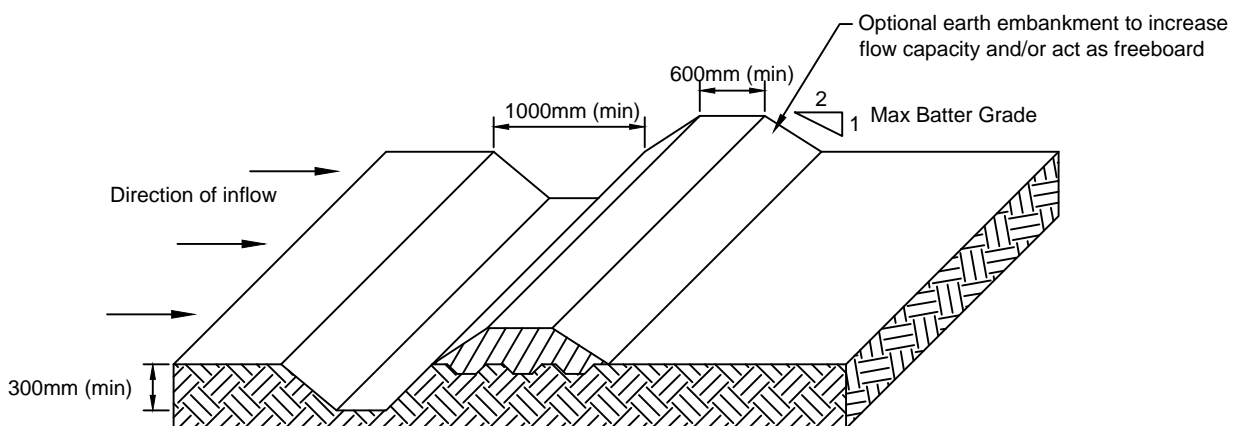
1. Turf should be used within 12 hours of delivery, otherwise ensure the turf is stored in conditions appropriate for the weather conditions (e.g. a shaded area).
2. Moistening the turf after it is unrolled will help maintain its viability.
3. Turf should be laid on a minimum 75mm bed of adequately fertilised topsoil. Rake the soil surface to break the crust just before laying the turf.
4. During the warmer months, lightly irrigate the soil immediately before laying the turf.
5. Ensure the turf is not laid on gravel, heavily compacted soils, or soils that have been recently treated with herbicides.
6. Ensure the turf extends up the sides of the drain at least 100mm above the elevation of the channel invert, or at least to a sufficient elevation to fully contain expected channel flow.
7. On channel gradients of 3:1(H:V) or steeper, or in situations where high flow velocities (i.e. velocity >1.5m/s) are likely within the first two week following placement, secure the individual turf strips with wooden or plastic pegs.
8. Ensure that intimate contact is achieved and maintained between the turf and the soil such that seepage flow beneath the turf is avoided.
9. Water until the soil is wet 100mm below the turf. Thereafter, watering should be sufficient to maintain and promote healthy growth

### Maintenance

1. During the site's construction period, inspect the diversion channel weekly and after any increase in flows within the channel. Repair any slumps, wheel track damage or loss of freeboard.
2. Ensure fill material or sediment is not partially blocking the channel. Where necessary, remove any deposited material to allow free drainage.
3. Dispose of any collected sediment or fill in a manner that will not create an erosion or pollution hazard.

### Removal

1. When the construction work above a temporary diversion channel is finished and the area is stabilised, the area should be appropriately rehabilitated.
2. Dispose of any collected sediment or fill in a manner that will not create an erosion or pollution hazard.
3. Grade the area and smooth it out in preparation for stabilisation.
4. Stabilise the area.



(a) Typical profile of diversion channel with bank

## Construction

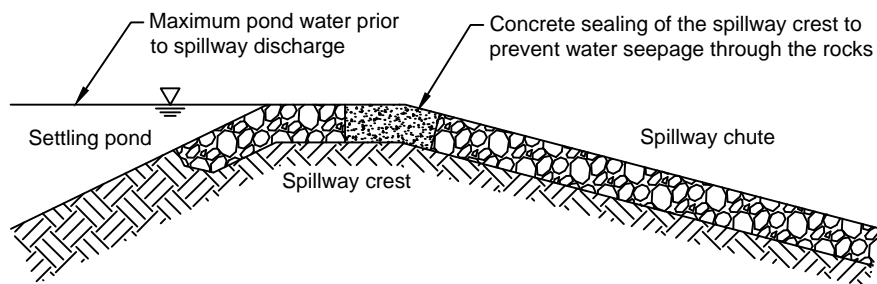
1. The spillway must be excavated, and the excavated material if classified as suitable, must be used in the embankment, and if not suitable it must be disposed of into spoil heaps.
2. Ensure excavated dimensions allow adequate boxing-out such that the specified elevations, grades, chute width, and entrance and exit slopes for the emergency spillway will be achieved after placement of the rock or other scour protection measures.
3. Place specified scour protection measures on the emergency spillway. Ensure the finished grade blends with the surrounding area to allow a smooth flow transition from spillway to downstream channel.
4. If a synthetic filter fabric underlay is specified, place the filter fabric directly on the prepared foundation. If more than 1 sheet of filter fabric is required, overlap the edges by at least 300mm and place anchor pins at minimum 1m spacing along the overlap. Bury the upstream end of the fabric a minimum 300mm below ground and where necessary, bury the lower end of the fabric or overlap a minimum 300mm over the next downstream section as required. Ensure the filter fabric extends at least 1000mm upstream of the spillway crest.
5. Take care not to damage the fabric during or after placement. If damage occurs, remove the rock and repair the sheet by adding another layer of fabric with a minimum overlap of 300mm around the damaged area. If extensive damage is suspected, remove and replace the entire sheet.
6. Where large rock is used, or machine placement is difficult, a minimum 100mm layer of fine gravel, aggregate, or sand may be needed to protect the fabric.
7. Placement of rock should follow immediately after placement of the filter fabric. Place rock so that it forms a dense, well-graded mass of rock with a minimum of voids. The desired distribution of rock throughout the mass may be obtained by selective loading at the quarry and controlled dumping during final placement.
8. The finished slope should be free of pockets of small rock or clusters of large rocks. Hand placing may be necessary to achieve the proper distribution of rock sizes to produce a relatively smooth, uniform surface. The finished grade of the rock should blend with the surrounding area. No overfall or protrusion of rock should be apparent.
9. Ensure that the final arrangement of the spillway crest will not promote excessive flow through the rock such that the water can be retained within the settling basin an elevation no less than 50mm above or below the nominated spillway crest elevation.

## Maintenance

1. During the construction period, inspect the spillway prior to forecast rainfall, daily during extended periods of rainfall, after significant runoff producing storm events, or otherwise on a weekly basis. Make repairs as necessary.
2. Check for movement of, or damage to, the spillway's lining, including surface cracking.
3. Check for soil scour adjacent the spillway. Investigate the cause of any scour, and repair as necessary.
4. When making repairs, always restore the spillway to its original configuration unless an amended layout is required.

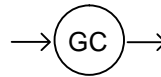
## Removal

1. Temporary spillways should be removed when an alternative, stable, drainage system is available.
2. Remove all materials and deposited sediment, and dispose of in a suitable manner that will not cause an erosion or pollution hazard.
3. Grade the area in preparation for stabilisation, then stabilise the area.



(a) Example of seepage control on the spillway crest

# Grass Channel Linings GC



## Installation

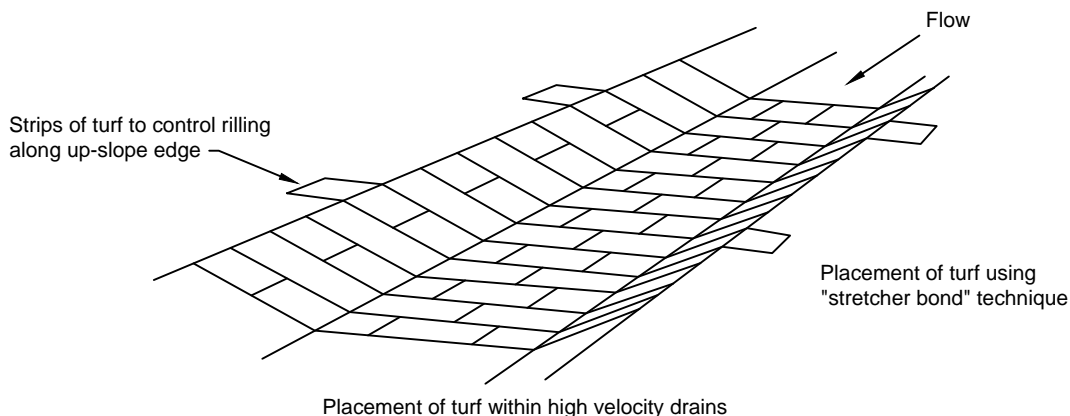
1. Ensure all necessary soil testing (e.g. soil pH, nutrient levels) and analysis has been completed, and required soil adjustments performed prior to planting.
2. Remove all trees, brush, stumps, and other objectionable material from the channel footprint and dispose of properly.
3. Excavate the channel and shape it to neat lines and dimensions shown on the approved plan. Ensure an adequate allowance in the excavated dimensions, typically 75mm, for the placement topsoil and turfing.
4. Remove and properly dispose of all excess soil so that surface water may enter the channel freely.
5. The procedures used to establish grass within the channel will depend upon the expected weather conditions, the type of grass, and the likely flow conditions within the channel during and immediately after planting. Ensure the adopted planting procedures are consistent with the approved plans or the recommendations of the landscape designers.

## Additional requirements when laying turf within a drainage channel:

1. Turf should be used within 12-hours of delivery, otherwise ensure the turf is stored in conditions appropriate for the weather conditions (e.g. a shaded area).
2. Moistening the turf after it is unrolled will help maintain its viability.
3. Turf should be laid on a minimum 75mm bed of adequately fertilised topsoil. Rake the soil surface to break the crust just before laying the turf.
4. During the warmer months, lightly irrigate the soil immediately before laying the turf.
5. Ensure the turf is not laid on gravel, heavily compacted soils, or soils that have been recently treated with herbicides.
6. Lay the first row of turf in a straight line diagonal to the direction of flow. Stagger subsequent rows in a brick-like (stretcher bond) pattern. The turf should not be stretched or overlapped. Use a knife or sharp spade to trim and fit irregularly shaped areas.
7. Ensure the turf extends up the sides of the channel at least 100mm above the elevation of the channel bed, or at least to a sufficient elevation to fully contain the expected channel flow that is considered likely to occur within the first month after placement.
8. On channel gradients of 3:1(H:V) or steeper, or wherever erosion may be a problem, or in situations where high flow velocities (i.e. velocity > 1.5m/s) are likely within the first 2-weeks following placement, secure the individual turf strips with wooden pegs.
9. Ensure that intimate contact is achieved and maintained between the turf and the soil such that seepage flow beneath the turf is avoided.
10. Where practicable, once fixed in place, the turf should be rolled with a roller weighing 60 to 90kg/m width, then watered.
11. After rolling, lightly spread screened topsoil to replace topsoil lost from the turf and to fill any gaps between the rows.
12. Water until the soil is wet 100mm below the turf. Thereafter, watering should be sufficient to maintain and promote healthy growth.

## Maintenance

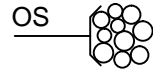
1. During the initial root establishment period, check grassed channels after every rainfall.
2. After grass is established, periodically check the channel including after significant storm events.
3. Check for erosion along the edge of the turfed area. If erosion is occurring, take appropriate measures to avoid further erosion.
4. If damage has occurred, immediately initiate repairs with turf or by seeding as appropriate.
5. Remove excessive sediment deposition or debris from the channel to maintain the channel's required hydraulic capacity.
6. Maintain a healthy and vigorous grass condition whenever and wherever possible, including watering and fertilising as needed.
7. Ensure a minimum grass leaf blade length of 50mm is maintained in areas subject to medium to high flow velocities, and 20 to 50mm in low velocity areas.
8. Mowing should not be attempted until the turf is firmly rooted, usually 2 to 3 weeks after laying.
9. All reasonable measures shall be taken to collect grass clippings immediately after mowing if their removal by subsequent channel flows would contaminate sensitive downstream waterways or otherwise cause undesirable environmental harm.



Reference: Witheridge 2010, *Erosion and Sediment Control - A field Guide for Construction Site Managers*. Catchments & Creeks Pty Ltd., Brisbane, Queensland

FILE NAME: Irrigation Tools\SWMP - Jarvis\SD-GC-1 Grass Channel Linings.dwg  
PRINTED: 12 October 2011

## Outlet Structure OS



### Materials (Rock pads)

\* Rock: hard, angular, durable, weather resistant and evenly graded with 50% by weight larger than the specified nominal rock size and sufficient small rock to fill the voids between the larger rock. The diameter of the largest rock size should be no larger than 1.5 times the nominal rock size. Specific gravity to be at least 2.5.

\* Geotextile fabric: heavy-duty, needle-punched, non-woven filter cloth, minimum 'bidim' A24 or equivalent.

### Installation (Rock pads)

1. The dimensions of the outlet structure must align with the dominant flow direction.
2. Excavate the outlet pad footprint to the specified dimension such that when the rock is placed in the excavated pit the top of the rocks will be level with the surrounding ground, unless otherwise directed.
3. If the excavated soils are dispersive, over-excavate the rock pad by at least 300mm and backfill with stable, non-dispersive material.
4. Line the excavated pit with geotextile filter cloth, preferably using a single sheet. If joints are required, overlap the fabric at least 300mm.
5. Ensure the filter cloth is protected from punching or tearing during installation of the fabric and the rock. Repair any damage by removing the rock and placing with another piece of filter cloth over the damaged area overlapping the existing fabric a minimum of 300mm.
6. Ensure there are at least two layers of rocks. Where necessary, reposition the larger rocks to ensure two layers of rocks are achieved without elevating the upper surface above the pipe invert.
7. Ensure the rock is placed in a manner that will allow water to discharge freely from the pipe.
8. Ensure the upper surface of the rock pad does not cause water to be deflected around the edge of the rock pad.
9. Immediately after construction, appropriately stabilise all disturbed areas.

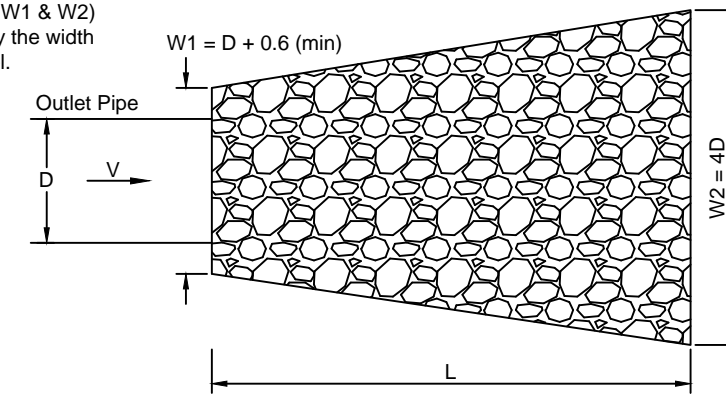
### Maintenance

1. While construction works continue on the site, inspect the outlet structure prior to forecast rainfall, daily during extended periods of rainfall, after significant runoff producing rainfall, and on at least a weekly basis.
2. Replace any displaced rock with rock of a significantly (minimum 110%) larger size than the displaced rock.

### Removal

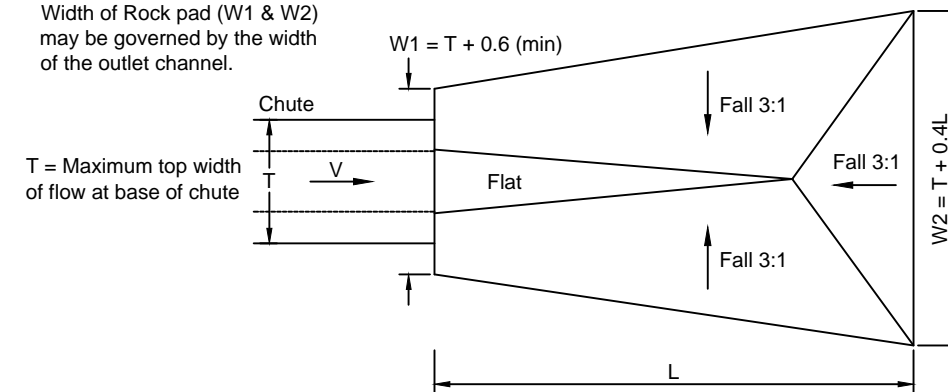
1. Temporary outlet structures should be completely removed, or where appropriate, rehabilitated so as not to cause ongoing environmental nuisance or harm.
2. Following removal of the device, the disturbed area must be appropriately rehabilitated so as not to cause ongoing environmental nuisance or harm.
3. Remove materials and collected sediment and dispose of in a suitable manner that will not cause an erosion or pollution hazard.

Width of Rock pad (W1 & W2) may be governed by the width of the outlet channel.



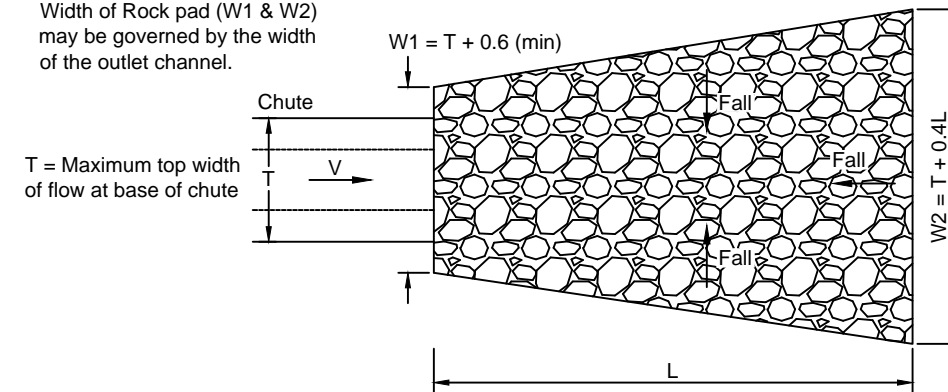
(a) Typical layout of rock pad outlet structure for pipe outlet

Width of Rock pad (W1 & W2) may be governed by the width of the outlet channel.

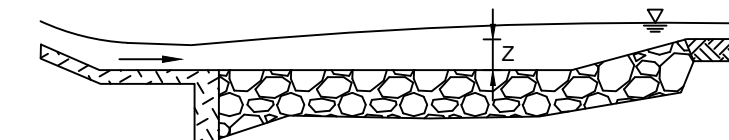


(b) Typical form of a rock pad outlet structure for a drainage chute

Width of Rock pad (W1 & W2) may be governed by the width of the outlet channel.



(c) Typical layout of a rock pad outlet structure for a drainage chute



(d) Typical profile of a rock pad outlet structure for a drainage chute

### Notes:

1. Drawings applicable to temporary drainage chutes and slope drains.
2. Rock pad outlet structures for slope drains usually are not required to be recessed below natural ground level as is the case for chute outlets (see figure b).

## Revegetation - General R



Specifications for site revegetation vary considerably from site to site. Site supervisors should obtain site specific planting specifications.

### Installation

1. Ensure all necessary soil testing (e.g. soil pH, nutrient levels) and analysis has been completed, and required soil adjustments performed prior to planting.
2. Apply soil conditioners and fertiliser as specified on the approved plans. Rip the soil 100 to 150mm to mix the components into the soil and to loosen and roughen the soil surface before seeding.
3. Where possible, there should be sufficient soil depth to provide an adequate root zone. The depth to rock or impermeable layers such as hardpans should be 300mm or more, except on slopes steeper than 2:1(H:V) where such soil depth may not be feasible.
4. Ensure the soil pH is within the specified range.
5. Apply seed uniformly by hand or with a cyclone seeder, drop-type spreader, drill, hydroseeder, hydromulcher, or other suitable equipment as specified.
6. When using broadcast-seeding methods, subdivide the area into workable sections and apply one-half the specified quantity of seed while moving back and forth across the area, making a uniform pattern. Then apply the second half in the same way, but moving at right angles to the first pass. Cover broadcast seed by raking or chain dragging; then firm the surface with a roller to provide good seed contact.
7. Apply seed at the recommended rate, and disc or otherwise mechanically treat the surface to bring the seed into contact with the soil.
8. The seeded area should be mulched as specified in the approved plan.

### Maintenance

1. During the construction phase, inspect the treated area fortnightly and after runoff-producing rainfall. Make repairs as needed.
2. Watering the vegetation periodically is essential, especially in the first 7 days after establishment. Use low-pressure sprays because high-pressure jets can wash away the seed and mulch cover.
3. Watering should start immediately after planting. Watering should comply with specifications provided with the approved plans. Generally watering should vary according to weather and soil conditions. A typical watering schedule may consist of the following:
  - \* 25mm every second day for the first three waterings;
  - \* 25mm twice a week for the next three weeks; and
  - \* 25mm once weekly for a further two weeks.
4. Monitor site revegetation, particularly after rainfall, and appropriate maintenance and/or amendment to ensure that the revegetation is controlling erosion and stabilising soil slopes as required.
5. Where practicable, fill in, or level out, any rill erosion between plants. If excessive erosion occurs, then consider increasing the planting density, applying appropriate erosion control measures, or introducing alternative, non-clumping plant species.
6. Areas must be re-seeded and mulched if the vegetation fails to establish or is damaged by runoff or construction activities.
7. If the temporary vegetation cover or erosion control measure (e.g. mulch cover) should fail for any reason before establishment of the permanent vegetation cover, then it must be replaced with an appropriate type of cover sufficient to control soil erosion.
8. If the permanent vegetation should fail to establish or to adequately restrain erosion for any reason during the construction or maintenance period, the area should be revegetated or protected with other erosion control measures as appropriate.
9. In areas where the obtained vegetation cover is considered inadequate for erosion control, the affected area should be over-seeded and fertilised using half the originally specified rates, or as directed.
10. Maintain grass blade length at a minimum 50mm height within medium to high velocity drainage areas, and 20 to 50mm within low velocity flow paths.
11. Where necessary, or as directed by the site supervisor, slash the temporary crop/grass cover to allow the successful growth of the underlying permanent vegetation cover.
12. Control weed growth within 1m of immature trees for 6 to 12 months for fast growing species, and 18 to 20 months for slower growing species, or until the end of the specified maintenance period.
13. Where mulch is used to control weed growth, inspect and where necessary, renew at maintenance periods not exceeding 4 to 6 months.
14. Apply additional seed, mulch and/or soil conditioning as required. Mulches usually need to be maintained or renewed (as necessary) 2 to 3 times a year.
15. Inspect and where necessary repair protective fencing at maintenance periods not exceeding 1 month.
16. Re-firm plants loosened by wind-rock, livestock or wildlife.
17. Replace dead or severely retarded plants.
18. Prune any plants of dead or diseased parts. Cut off all damaged tree limbs above the tree collar at the trunk or main branch. Use several cuts including undercutting to avoid peeling bark from the healthy areas of the tree.
19. Dispose of cleared vegetation in an appropriate manner such as chipping or mulching, on-site burial, or off-site disposal. Cleared vegetation should not be dumped near a watercourse or on a floodplain where it could be removed by floodwaters. Vegetation should not be burnt on-site without specific approval from the local authority.
20. Repair damaged tree roots by cutting off the damaged areas and sealing them with an approved product. Spread moist topsoil over exposed roots.

Reference: Witheridge 2010, *Erosion and Sediment Control - A field Guide for Construction Site Managers*. Catchments & Creeks Pty Ltd., Brisbane, Queensland

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PRINTED: 21 October 2011  
21 October 2011

# Rock Check Dam RCD



## Materials

\* Rock: 150 to 300mm nominal diameter, hard, erosion resistant rock. Smaller rock may be used if suitable large rock is not available.

\* Sandbags: geotextile bags (woven synthetic, or non-woven biodegradable) filled with clean coarse sand, clean aggregate, straw or compost.

## Installation

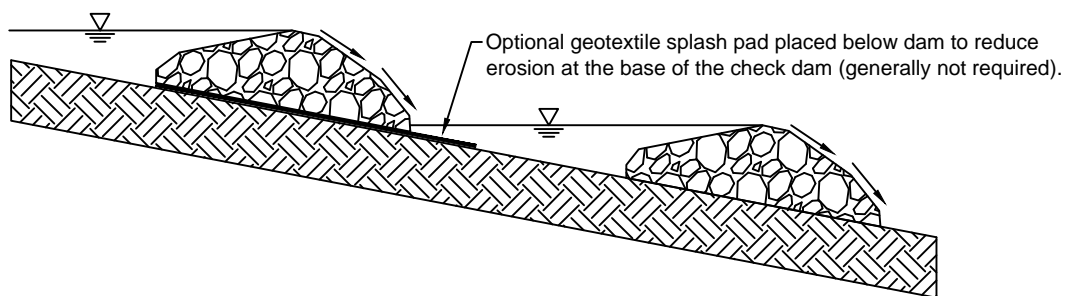
1. Prior to placement of the check dams, ensure the type and size of each check dam will not cause a safety hazard or cause water to spill out of the drain.
2. Locate the first check dam at the downstream end of the section of channel being protected. Locate each successive check dam such that the crest of the immediate downstream dam is level with the toe of the check dam being installed.
3. Ensure the channel slope is no steeper than 10:1 (H:V). Otherwise consider the use of a suitable channel liner instead of the check dams.
4. Construct the check dam to the dimensions and profile shown within the approved plan.
5. Where specified, the check dams shall be constructed on a sheet of geotextile fabric used as a downstream splash pad.
6. Each check dam shall be extended up the channel bank (where practicable) to an elevation at least 150mm above the crest level of the dam.

## Maintenance

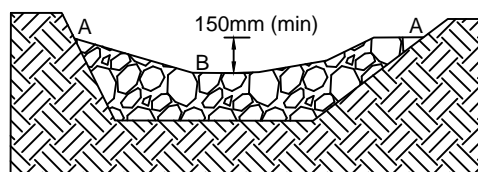
1. Inspect each check dam and the drainage channel at least weekly and after runoff-producing rainfall.
2. Correct all damage immediately. If significant erosion occurs between any of the check dams, then check the spacing of dams and where necessary install intermediate check dams or a suitable channel liner.
3. Check for displacement of the check dams
4. Check for soil scour around the ends of each check dam. If such erosion is occurring, consider extending the width of the check dam to avoid such problems.
5. If severe soil erosion occurs either under or around the check dams, then seek expert advice on an alternative treatment measure.
6. Remove any sediment accumulated by the check dams, unless it is intended that this sediment will remain within the channel.
7. Dispose of collected sediment in a suitable manner that will not cause an erosion or pollution hazard.

## Removal

1. When construction work within the drainage area above the check dams has been completed, and the disturbed areas and the drainage channel are sufficiently stabilised to restrain erosion, all temporary check dams must be removed.
2. Remove the check dams and associated sediment and dispose of in a suitable manner that will not cause an erosion or pollution hazard.



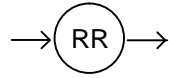
(a) Layout of check dams (rock check dams shown)



Outer wing points A to be at least 150mm above crest level B

(b) Profile of check dams (rock check dams shown)

# Rock Linings RR



## Materials

\* Rock: hard, angular, durable, weather resistant and evenly graded with 50% by weight larger than the specified nominal rock size and sufficient small rock to fill the voids between the larger rock. The diameter of the largest rock size should be no larger than 1.5 times the nominal rock size. Specific gravity to be at least 2.5.

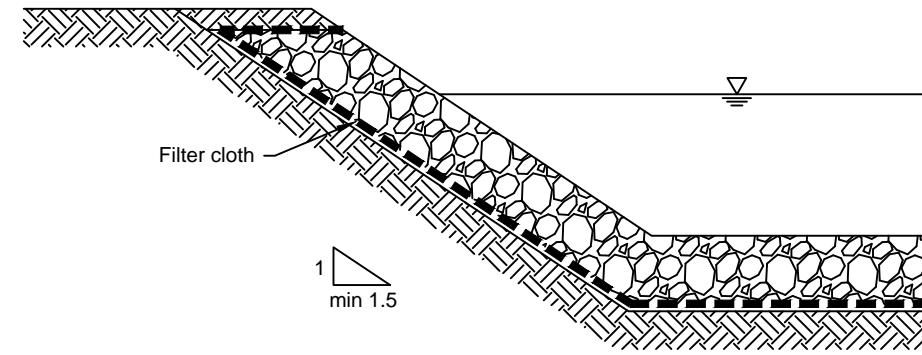
\* Geotextile fabric: heavy-duty, needle-punched, non-woven filter cloth, minimum 'bidim' A24 or equivalent.

## Installation

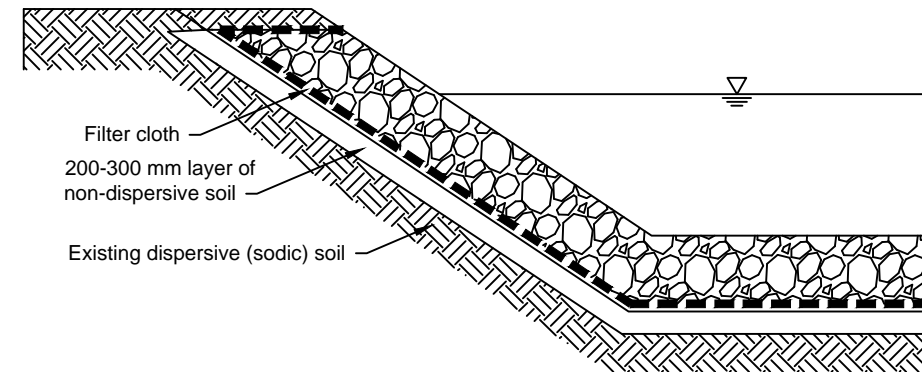
1. Clear the proposed channel area of trees, stumps, roots, loose rock, and other objectionable materials.
2. Excavate the channel to the lines and grades as shown on the plans. Over-cut the channel to a depth equal to the specified depth of rock placement such that the finished rock surface will be at the elevation of the surrounding land.
3. Rock must be placed within the channel, including the placement of any specified filter layer.
4. If details are not provided on the rock placement, then the primary armour rock must be either placed on:
  - \* a filter bed formed from a layer of specified smaller rock (rock filter layer);
  - \* an earth bed lined with filter cloth;
  - \* an earth bed not lined in filter cloth, but only if all voids between the armour rock are to be filled with soil and pocket planted immediately after placement of the rock.
5. If a rock/aggregate filter layer is specified, then place the filter layer immediately after the foundations are prepared. Spread the filter rock in a uniform layer to the specified depth but a minimum of 150mm. Where more than one layer of filter material has been specified, spread each layer such that minimal mixing occurs between each layer of rock.
6. If a geotextile (filter cloth) underlay is specified, place the fabric directly on the prepared foundation. If more than one sheet of fabric is required to cover the area, overlap the edge of each sheet at least 300mm and place anchor pins at minimum one metre spacing along the overlap.
7. Ensure the geotextile fabric is protected from punching or tearing during installation of the fabric and the rock. Repair any damage by removing the rock and placing with another piece of filter cloth over the damaged area overlapping the existing fabric a minimum of 300mm.
8. Where necessary, a minimum 100mm layer of fine gravel, aggregate or sand should be placed over the fabric to protect it from damage.
9. Placement of rock should follow immediately after placement of the filter layer. Place rock so that it forms a dense, well-graded mass of rock with a minimum of voids.
10. Place rock to its full thickness in one operation. Do not place rock by dumping through chutes or other methods that cause segregation of rock sizes.
11. The finished surface should be free of pockets of small rock or clusters of large rocks. Hand placing may be necessary to achieve the proper distribution of rock sizes to produce a relatively smooth, uniform surface. The finished grade of the rock should blend with the surrounding area. No overfall or protrusion of rock should be apparent.
12. Immediately upon completion of the channel, vegetate all disturbed areas or otherwise protect them against soil erosion.
13. Where specified, fill all voids with soil and vegetate the rock surface.

## Maintenance

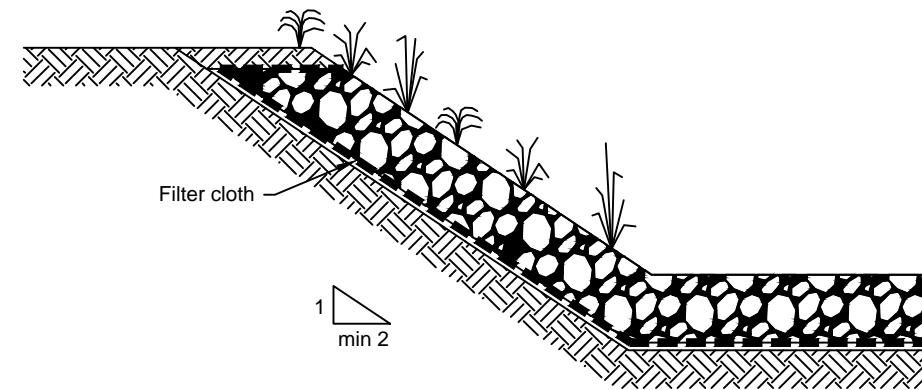
1. Rock-lined channels should be inspected periodically and after significant storm events. Check for scour or dislodged rock. Repair damaged areas immediately.
2. Closely inspect the outer edges of the rock protection. Ensure water entry into the channel or chute is not causing erosion along the edge of the rock protection.
3. Carefully check the stability of the rock looking for indications of piping, scour holes, or bank failures.
4. Replace any displaced rock with rock of a significantly (minimum 110%) larger size than the displaced rock.



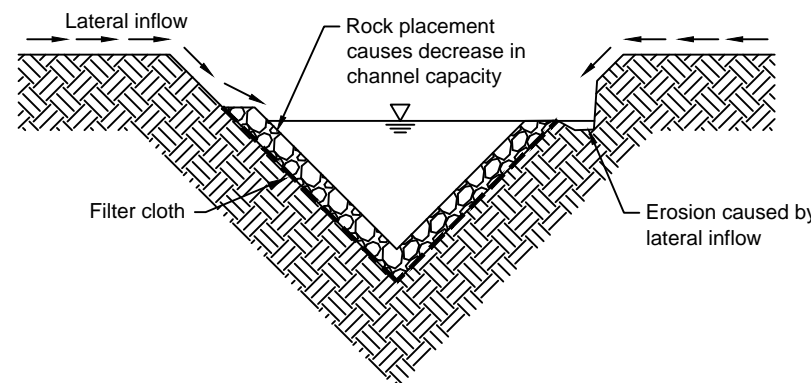
(a) Placement of rock with open voids



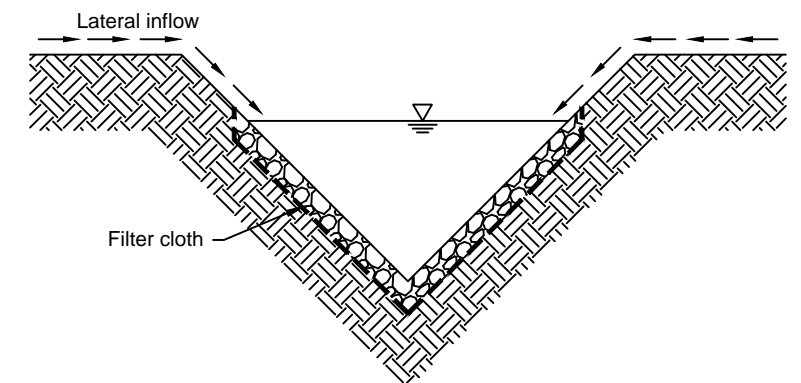
(b) Placement of rock within a channel cut into dispersive soils



(c) Placement of rock with voids filled with soil and vegetated



(d) Poor placement of rock along channel invert

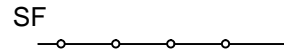


(e) Good placement of rock along channel invert

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 PRINTED: 12 October 2011  
 CREATED: 12 October 2011

Reference: Witheridge 2010. Erosion and Sediment Control - A field Guide for Construction Site Managers. Catchments & Creeks Pty Ltd., Brisbane, Queensland

# Sediment Fence SF



## Materials

\* Fabric: polypropylene, polyamide, nylon, polyester, or polyethylene woven or non-woven fabric, at least 700mm in width and a minimum unit weight of 140GSM. All fabrics to contain ultraviolet inhibitors and stabilisers to provide a minimum of 6 months of useable construction life (ultraviolet stability exceeding 70%).

\* Fabric reinforcement: wire or steel mesh minimum 14-gauge with a maximum mesh spacing of 200mm.

\* Support posts/stakes: 1500mm<sup>2</sup> (min) hardwood, 2500mm<sup>2</sup> (min) softwood, or 1.5kg/m (min) steel star pickets suitable for attaching fabric.

## Installation

- To the maximum degree practical, and where the plans allow, ensure the fence is located:
  - totally within the property boundaries;
  - along a line of constant elevation wherever practical;
  - at least 2m from the toe of any filling operations that may result in shifting soil/fill damaging the fence.
- Install returns within the fence at maximum 20m intervals if the fence is installed along the contour, or 5 to 10m maximum spacing (depending on slope) if the fence is installed at an angle to the contour. The 'returns' shall consist of either:
  - V-shaped section extending at least 1.5m up the slope; or
  - sandbag or rock/aggregate check dam a minimum 1/3 and maximum 1/2 fence height, and extending at least 1.5m up the slope.
- Ensure the extreme ends of the fence are turned up the slope at least 1.5m, or as necessary, to minimise water bypassing around the fence.
- Ensure the sediment fence is installed in a manner that avoids the concentration of flow along the fence, and the undesirable discharge of water around the ends of the fence.
- If the sediment fence is to be installed along the edge of existing trees, ensure care is taken to protect the trees and their root systems during installation of the fence. Do not attach the fabric to the trees.
- Unless directed by the site supervisor, excavate a 200mm wide by 200mm deep trench along the proposed fence line, placing the excavated material on the up-slope side of the trench.
- Along the lower side of the trench, appropriately secure the stakes into the ground spaced no greater than 3m if supported by a top support wire or weir mesh backing, otherwise no greater than 2m.
- If specified, securely attach the support wire or mesh to the up-slope side of the stakes with the mesh extending at least 200mm into the excavated trench. Ensure the mesh and fabric is attached to the up-slope side of the stakes even when directing a fence around a corner or sharp change-of-direction.
- Wherever possible, construct the sediment fence from a continuous roll of fabric. To join fabric either:
  - attach each end to two overlapping stakes with the fabric folding around the associated stake one turn, and with the two stakes tied together with wire (Method 1); or
  - overlap the fabric to the next adjacent support post (Method 2).
- Securely attach the fabric to the support posts using 25 x 12.5mm staples, or tie wire at maximum 150mm spacing.
- Securely attach the fabric to the support wire/mesh (if any) at a maximum spacing of 1m.
- Ensure the completed sediment fence is at least 450mm, but not more than 700mm high. If a spill-through weir is installed, ensure the crest of the weir is at least 300mm above ground level.
- Backfill the trench and tamp the fill to firmly anchor the bottom of the fabric and mesh to prevent water from flowing under the fence.
- If it is not possible to anchor the fabric in an excavated trench, then use a continuous layer of sand or aggregate to hold the fabric firmly on the ground.

## Additional requirements for the installation of a spill-through weir

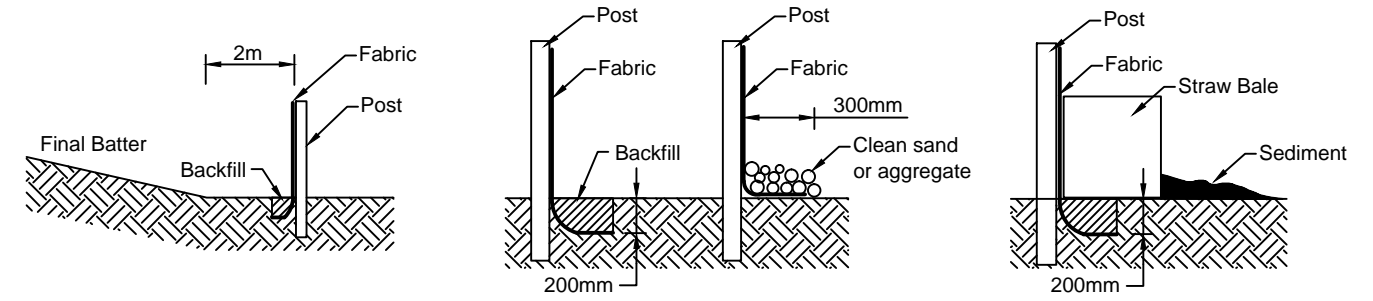
- Locate the spill-through weir such that the weir crest will be lower than the ground level at each end of the fence.
- Ensure the crest of the spill-through weir is at least 300mm the ground elevation.
- Securely tie a horizontal cross member (weir) to the support posts/stakes each side of the weir. Cut the fabric down the side of each post and fold the fabric over the cross member and appropriately secure the fabric.
- Install a suitable splash pad and/or chute immediately down-slope of the spill-through weir to control soil erosion and appropriately discharge the concentrated flow passing over the weir.

## Maintenance

- Inspect the sediment fence at least weekly and after any significant rain. Make necessary repairs immediately.
- Repair any torn sections with a continuous piece of fabric from post to post.
- When making repairs, always restore the system to its original configuration unless an amended layout is required or specified.
- If the fence is sagging between stakes, install additional support posts.
- Remove accumulated sediment if the sediment deposit exceeds a depth of 1/3 the height of the fence.
- Dispose of sediment in a suitable manner that will not cause an erosion or pollution hazard.
- Replace the fabric if the service life of the existing fabric exceeds 6-months.

## Removal

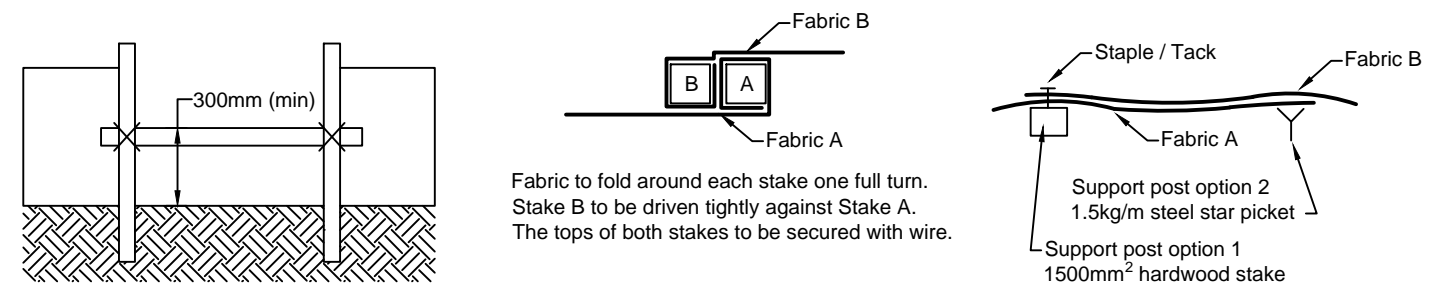
- When disturbed areas up-slope of the sediment fence are sufficiently stabilised to restrain erosion, the fence must be removed.
- Remove materials and collected sediment and dispose of in a suitable manner that will not cause an erosion or pollution hazard.
- Rehabilitate/revegetate the disturbed ground as necessary to minimise the erosion hazard.



(a) Location of fence relative to base of slope

(b) Anchoring base of fabric

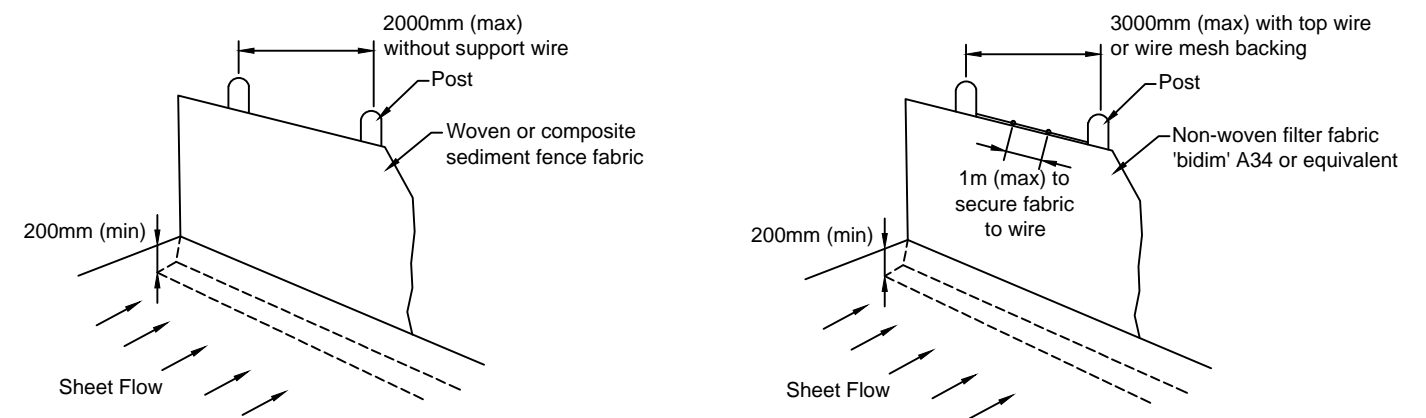
(c) Placement of up-slope straw bale



(d) Spill-through weir

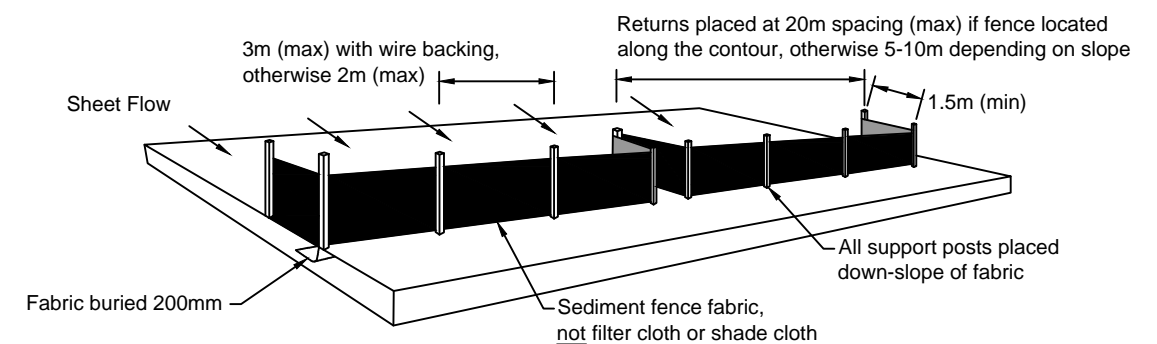
(e) Joining fabric - Method 1

(f) Joining fabric - Method 2



(g) Installation without backing support

(h) Installation with top wire support



(i) Installation of sediment fence

# Appendix C

## *EPBC Offset Assessment Guide (OAG) – Macadamia integrifolia*



