Launching Place WA375, VIC 3175

Hydrology Assessment including Water Balance and Drainage Investigation

Dandy Premix Quarries Pty Ltd

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WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS

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ACRONYMS

EPA	Environment Protection Authority
AHD	Australian Height Datum
DEECA	Department of Energy, Environment and Climate Action
GIS	Geographic Information System
LiDAR	Light Detection and Ranging
DEECA-ERR	Earth Resource Regulation
WPV	Work Plan Variation
MRSDA	Mineral Resource Sustainable Development Act
BOM	Bureau of Meteorology
L-AWRA	The Australian Landscape Water Balance Model
DEM	Digital Elevation Model
TSS	Total Suspended Solids
AWBM	The Australian Water Balance Model
RRL	Rainfall Runoff Library
ANZG	Australian and New Zealand Guidelines for Fresh and Marine Water Quality
NWQMS	National Water Quality Management Strategy
TDS	Total Dissolved Solids
EMS	Energy Management Services
AEP	Annual Exceedance Probability

1 INTRODUCTION

Dandy Premix Quarries Pty Ltd ('Dandy Premix') is seeking to expand their currently approved quarrying operations at the WA357 Launching Place site. The quarry expansion is presented in Figure 1-1, adding 17.9 ha of disturbed area to the current quarry. The following report provides information on a detailed water balance assessment undertaken as part of the planning process. Consultation with John Leonard Consulting Services in relation to groundwater flow rates (both in and out of the pit) along with estimated water quality were undertaken in the preparation of this report. Throughout the report, the current Works Area and proposed expansion areas are referred to as the 'site'.

1.1 Current Operation

Currently, Dandy Premix operate a quarry approximately 23.3 ha producing crushed rock and aggregate products from its Launching Place Quarry. The quarry has an open pit, processing area, crushing plant, material storage area access roads, several dams and other infrastructure. It is understood the existing quarry has been operating since the mid 1980's with an extension to the Works Authority permit (WA375) issued in 1996. Under the works authority permit the management of surface water was required and detailed assessments were carried out. A previous surface water assessment undertaken the extension of the quarry was carried out by Neil M Craigie P/L in 2009, and is referenced throughout this report as part of the current investigation. A schematic of the surface water management features of the current quarry operation is provided in Figure 3-2.

It is our understanding the existing drainage system incorporates the following items:

- Surface water is collected from the local catchment (Tributary 1), with some water harvested on site through the storage in two dams located onsite.
- Water is collected at the bottom of the Extraction Pit. It is proposed to be progressively backfilled with overburden stripped from the new (Lot 50C) extraction area. The water storage (sump) at the base of the existing pit (WL 193.4m AHD), will be relocated to match backfilling so that it continues to receive flows and acts as a source of water for the Holding Dam.
- The Holding Dam (4,100 m², WL 238.9 m AHD) receives all water pumped out of the Extraction Pit with an estimated ponded volume of 10ML.
- The Main Dam (2,000 m², WL 227.6 m AHD) receives the bulk of the drainage from the processing/stockpiling area in Work Authority No. WA 375 with an estimated ponded volume of 5ML.
- Water captured on site is used on site for dust suppression and as part of the processing operation.
- Initially, the quarry had an EPA discharge licence (EW 811/2) for an outfall drain which was revoked in April 2011, as there was no discharge from the site. Higher seasonal inflows that exceed the capacity of the Holding Dam are discharged in a south-west direction, via a installed 300 mm discharge pipe to a Tributary of Ure Creek.
- Stormwater runoff from the southern portion of the site is discharged into the Ure Creek via a rock and concrete lined drain along McMahons Road.

It is estimated the current operation area has a number of years of quarrying activity remaining. Several areas of the current operation have been quarried and are undergoing rehabilitation through the placement of overburden and revegetation. The current operation sits immediately south of the proposed expansion.

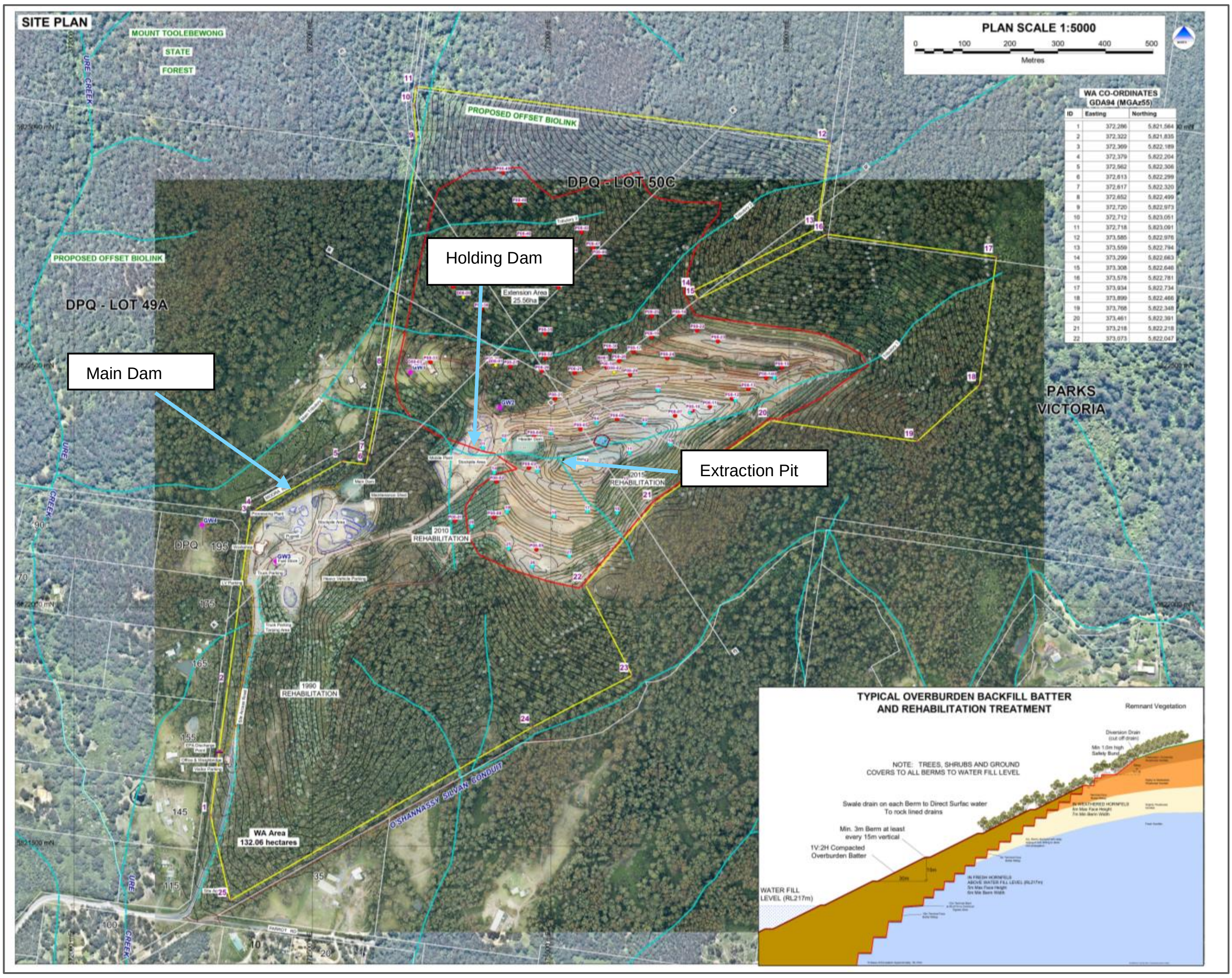

Figure 1-1 Existing Extraction Area and Proposed Future Extraction Area (Source: BCA Consulting)

1.2 Proposed Expansion

The proposed expansion is planned to work north from the existing quarry Works Authority Permit (WA375) area into the Lot50C where a planned disturbed area of 25.2 ha will be quarried. This report focuses on the surface water impacts of the proposed expansion and will form part of a Work Plan Variation (WPV) application to the Department of Energy, Environment and Climate Action (DEECA).

The expansion proposal crosses two small tributaries that are identified as waterways in the VicMAP GIS database (Tributary 2 & 3 in Figure 4-11). The tributaries are located within Lot 50C, shown in Figure 1-1. As the proposed expansion increases, the pit will capture Tributary 2 and the upstream catchment and direct all flows into the quarry sump, this is anticipated to be in a 3-5 year timeframe. Tributary 3 is expected to be intercepted in a 10-15 year timeframe. The final pit is proposed to be excavated to an invert elevation of 110 m AHD, around 80m lower than the current pit level.

It is understood the current processing area, access roads and other infrastructure are to be maintained. The management of surface water from the site is to be maintained with no free uncontrolled discharge of stormwater occurring from the site.

As part of the expansion, the surface water management system is likely to require several modifications from its current form.

- Management of tributary flows from upstream of the future extraction area (onsite capture, storage, usage and release).
- Rehabilitation of current approved extraction area and management of upstream tributary flows.

2 BACKGROUND

The subject site is located within a small gully tributary within the Ure Creek catchment, located around 4km north of Woori Yallock in the Shire of Yarra Ranges municipality. The site is within a Melbourne Water catchment, as Ure Creek outfalls to the Yarra River several kilometres downstream of the site. Much of the Ure Creek catchment is native bushland with small pockets of cleared land used for agriculture, low density or rural living housing and quarrying/extraction operations.

Water Technology previously undertook a study in 2021, which included a high-level water balance study using MUSIC modelling software. The MUSIC model assessed a developed quarry scenario (incorporating the proposed expansion) to estimate the annual volume that would drain to the future extraction area as a result of intercepting two tributaries north of the existing quarry. The study aimed to identify possible mitigation solutions for the waterway interceptions while assessing the likely impacts on the receiving waterway (Ure Creek). The study found diversion of the tributaries was not feasible due to the terrain limiting adequate drainage that would hinder construction and likely result in loss of native vegetation.

This study developed a detailed water balance model using eWater Source software to simulate catchment runoff under existing conditions and four different stages of the proposed expansion, simulating the conditions into the future. The updated water balance model also included:

- Quarry Storages.
- Consumption for quarry operations.
- Expected flow releases to the Ure Creek system.
- Changes to Ure Creek System flows.

The water balance model is required to meet requirements of Melbourne Water and the Victorian EPA in seeking a discharge permit.

- The water balance model used daily rainfall data over the available period of record (> 60 years) to simulate catchment runoff from the quarry in its current Works Authority area (existing conditions) as a baseline assessment. The rainfall from nearby gauges was verified against daily rainfall captured at the site over the past 10 years.
- The existing conditions model included topography based on LiDAR captured in 2015, current land use (i.e. forest area and cleared land), the current quarry pit configuration and current dam/basin setup.
- For various stages of the proposed Works Authority expansion, the model was revised to reflect the changing pit and runoff conditions at the site based on pit designs provided by BCA consulting (Figure 2-1).

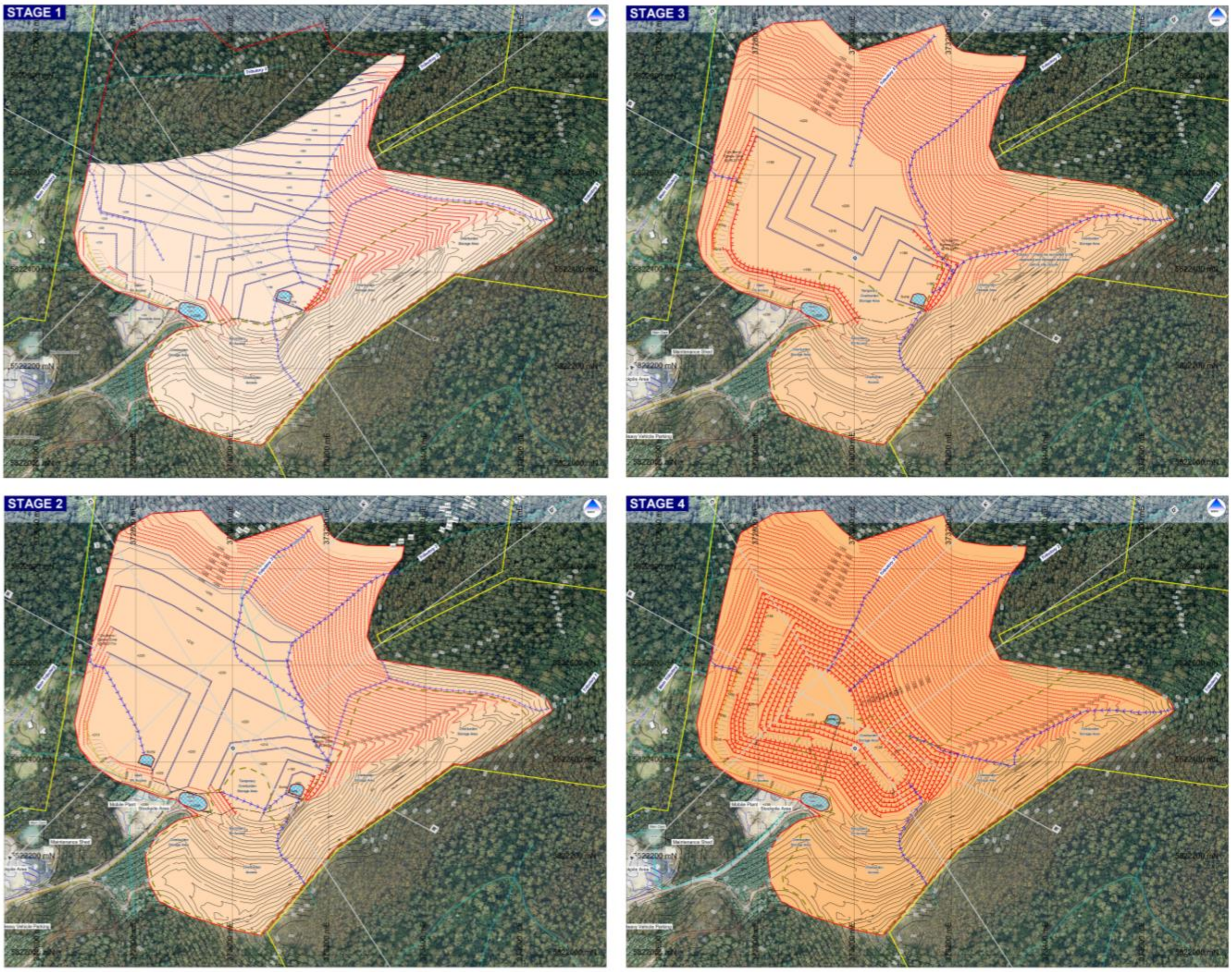

Figure 2-1 Four Stages of Proposed Expansion Source: BCA Consulting

2.1 Previous Investigation

Previous studies reviewed and collated as part of this project included:

- 1996 (October) – *Proposed Extension to Hard Rock Quarry, McMahons Road, Launching Place-Drainage And Water Quality Issues*[1], Neil M Craigie P/L.
- 2009 (July) - *Drainage and Water Quality Management Report*[2] Prepared by Neil M Craigie P/L in July 2009. This report was prepared as part of the background investigation for the extension the rock quarry. The report provided details of annual rainfall data, expected runoff volumes and an assessment of the water quality discharging from the site. Recommendations were also made for future monitoring programs and design and construction of the new haul road.
- 2009 (July) *Hydrogeological Assessment - Proposed Extension to Yarra Valley Quarries hard rock quarry, McMahon Road, Launching Place*[3], JLCS. Groundwater assessments have been completed by John Leonard Consulting Services. It is understood that additional groundwater work is being assessed outside of this report.
- 2009 (September) - *Drainage and water quality management (summary for Quarry Manager*[4]*)* Prepared by Neil M Craigie P/L. This addendum/memo provided details of the management and monitoring of water quality for the site including Haul Road Management, Outfall Drain at McMahons Road, Water Quality monitoring regime and locations.
- 2010 (July) - *McMahons Road outfall drain proposed water quality management works*[5] Prepared by Neil M Craigie P/L. This is a short memo/letter which provided advice to address water quality issues associated with residual discharge of sediments from the quarry access road.
- 2011 (April) – EPA *Revocation of Licence EW811*[6]. The discharge licence was revoked as the EPA found "there is no waste discharge from the premises to the environment".
- 2021 (July) – Water Technology – *Hydrology Assessment – Drainage Impacts*.

2.2 Objectives

The report has been prepared to address surface water hydrology requirements necessary to satisfy the requirements of DEECA-ERR (Earth Resources Regulation) under the *Mineral Resources (Sustainable Development) Act 1990* (the 'MRSDA'), along with those of the WA375, ERR Work Plan Variation (WPV) application, Statutory Referral Agencies, including EPA Victoria and Melbourne Water under the *Planning and Environment Act 1987*.

Water Technology submitted a pre-development advice application for the site (November 2020) at 130 McMahons Road, Launching Place to Melbourne Water on behalf of Dandy Premix Pty to assist in the preparation of our surface water report (attached as an Appendix B). A response was received from Melbourne Water, which indicated a surface water and drainage report should be provided for the proposed expansion and detailed the elements to be included in the report. The response also included a list of preliminary development requirements to accompany the application. These were as follows:

- Hydraulic advice:
  - The following hydraulic objectives are provided for consideration to be included in the preparation of a 'Surface Water and Drainage Report' for the proposed expansion:
    - Requirements from Southern Rural Water / Melbourne Water Diversions Team regarding any diversion of catchment flows into a quarry pit. The DEECA–Earth Resources Regulation department may also have guidelines regarding allowing upstream catchment flows to enter the extraction area.

        - How any alterations to a watercourse alignment will be undertaken throughout the various stages of the quarry operations and particularly the rehabilitation works that will have any realigned watercourses established in a manner that has ongoing maintenance obligations no greater than the watercourse in its undisturbed natural form.
        - How stormwater runoff from any disturbed area(s) within the work authority will be managed to ensure no polluted or sediment laden runoff discharges out of the work authority area unless approved under an EPA licensed discharge.
        - Existing / proposed stormwater treatment facilities to be outlined with an indicative maintenance program.
- Waterway health requirements
    - The surface water and drainage report for the site will need to be submitted to Melbourne Water for review and approval, demonstrating the impact of the development on the waterways on and near the works area and how stormwater and wastewater will be managed on the site. This report should include:
        - LiDAR or topographic assessment, to show both the current natural surface level as well as the potential change in landform as a result of the development.
        - An assessment of groundwater influence on the waterways on site, and the potential impacts on the groundwater table.
        - Flooding analysis showing the impact on flood levels downstream of the site.
        - There should be no increase in flood risk to neighbouring properties or nearby public assets as a result of the proposed works.
        - An assessment of catchment yield and provisions for adequate passing flows being released to waterways downstream of the site to maintain natural flow.
- Additional details that should be included are:
    - Detail regarding proposed drainage management for the site to support adequate treatment and management of stormwater and wastewater runoff generated by the proposed expansion.
    - An indication of the distance between the proposed excavation and top of bank to waterways on or near the site and the impact the excavation will have on the surrounding land surface and catchment.
    - The extent of intended cut/fill on the site including depth and location of any waste stockpiles.

3 CATCHMENT

The site which consists of the WA375 Works Area and proposed expansion areas is located within a gully tributary of the Ure Creek catchment, located around 4km north of Woori Yallock in the Shire of Yarra Ranges municipality.

The site is within a Melbourne Water catchment, as Ure Creek outfalls to the Yarra River several kilometres downstream of the quarry. Much of the Ure Creek catchment is native bushland with small pockets of cleared land used for agriculture, low density or rural living housing and quarrying/extraction operations.

The contributing catchment and waterways were delineated based on 1 m resolution topography data (LiDAR) using a catchment delineation algorithm developed for ArcGIS (Figure 3-1).

Ure Creek has a total catchment area of 876 hectares, with the top of the catchment 3km north of the site (Mt Toolebewong). Ure Creek outfalls to the Yarra River around 2.5km to the south. An unnamed tributary referred to as Moora Creek throughout this report outfalls to Ure Creek 500m downstream of the site and has a total catchment area of 440 hectares. A detailed breakdown of the catchment and the waterways is provided in Section 3.1.

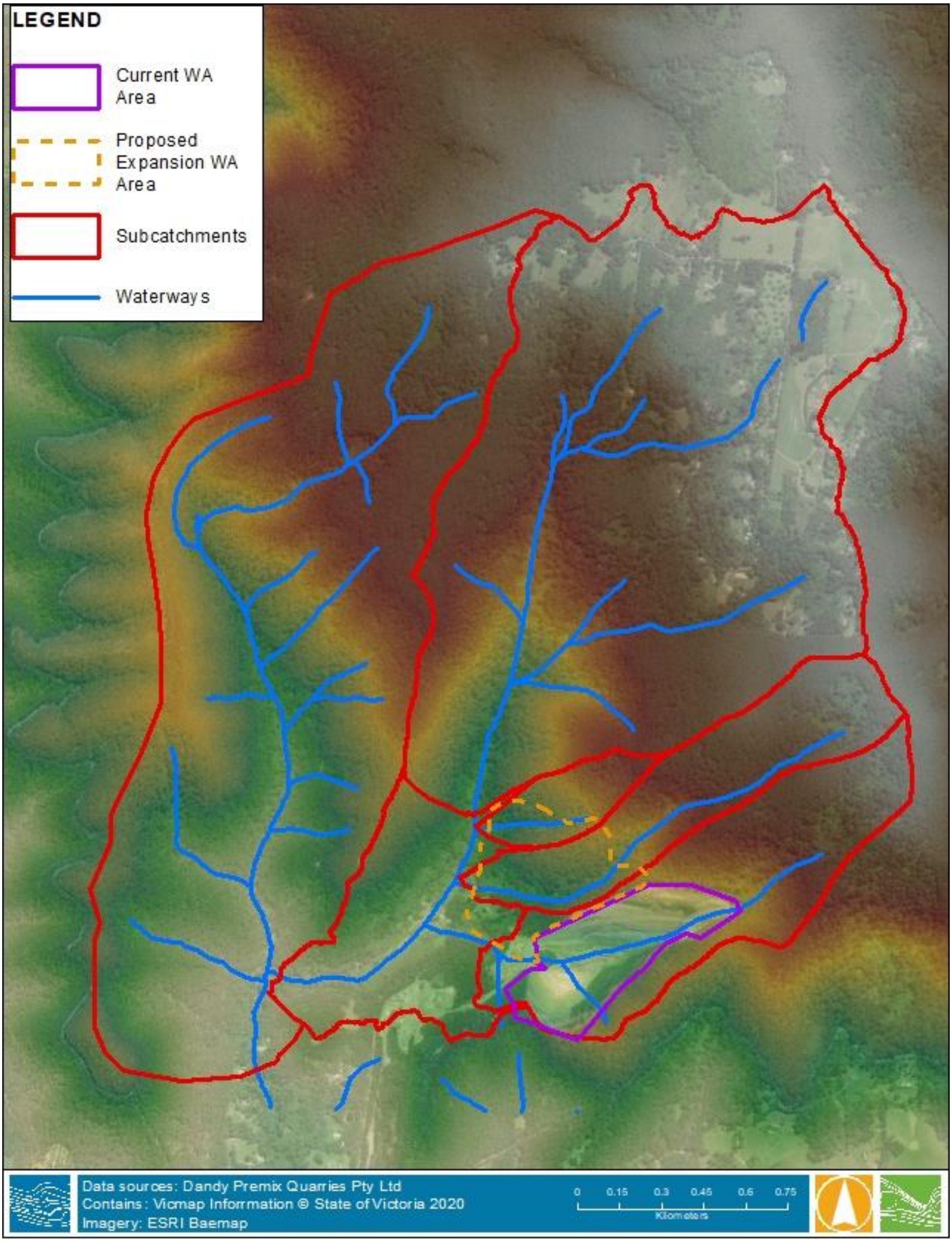

Figure 3-1 Catchment contributing to the study site

3.1 Waterways

There are five reaches of Ure Creek discussed throughout the report. A summary of the catchment area and hierarchy of the waterways is described below and shown in Figure 3-2 while photos of the waterways are also provided in Section 3.2.

- Ure Creek – has a catchment area of 876 hectares and outfalls to the Yarra River 2.5 km south of the site. The waterway is relatively narrow at the McMahons Road Crossing (Figure 3-3).
- Moora Creek - has a catchment area of 440 hectares and outfalls to Ure Creek 500m west of the site. The waterway is relatively shallow with small rock and clay creek bed. Adjacent to the subject site, the waterway appears to have been modified to construct several small ponds (Figure 3-3).
- Tributary 1 – has a catchment area of 72 hectares and is intercepted by the quarry and current pit. Surface water flows into the pit from the upstream catchment (40ha), with some water harvested on site at the Holding Dam and Main Dam, with excess flows outfalling to Moora Creek to the west of the quarry pit within Lot 49C (Figure 3-4).
- Tributary 2 – has a catchment area of 45 hectares and outfalls to the Moora Creek. Under the WPV the catchment area is to be intercepted by the quarry and current pit. Surface water flows into the pit from the upstream catchment (32ha), will enter the Extraction Pit and combine with runoff from the Tributary 1 catchment, with some water harvested on site through the Holding Dam and Main Dam located onsite with excess flows outfalling to Moora Creek to the west of the quarry pit within Lot 49C. Under the WPV, this tributary is expected to be intercepted within 3-5 years of the start of the proposed expansion (Figure 3-4). At the location of the photo point (taken approximately 100m upstream of confluence with Moora Creek), shows there is not a clearly defined waterway along this section and is more of a drainage path.
- Tributary 3 - has a catchment area of 12 hectares and outfalls to Moora Creek. Under the WPV, the catchment area is to be intercepted by the quarry and current pit. Surface water flows into the pit from the upstream catchment (7ha), will enter the Extraction Pit and combine with runoff from the Tributary 1 and Tributary 2 catchments, with some water harvested on site through the storage in the Holding Dam and Main Dam located onsite with excess flows outfalling to Moora Creek to the west of the quarry pit within Lot 49C. Under the WPV, this tributary is expected to be intercepted within 10-15 years of the start of the proposed expansion.

3.2 Site Visit

A site visit was conducted on May 26, 2022. The Extraction Pit, Holding Dam, Moora Creek and the gully/drainage lines of Tributary 2 and 3 were inspected along with the McMahons Road crossing (culvert) of Ure Creek. Photos of the two creeks and tributaries/drainage lines are shown in Figure 3-3 and Figure 3-4.

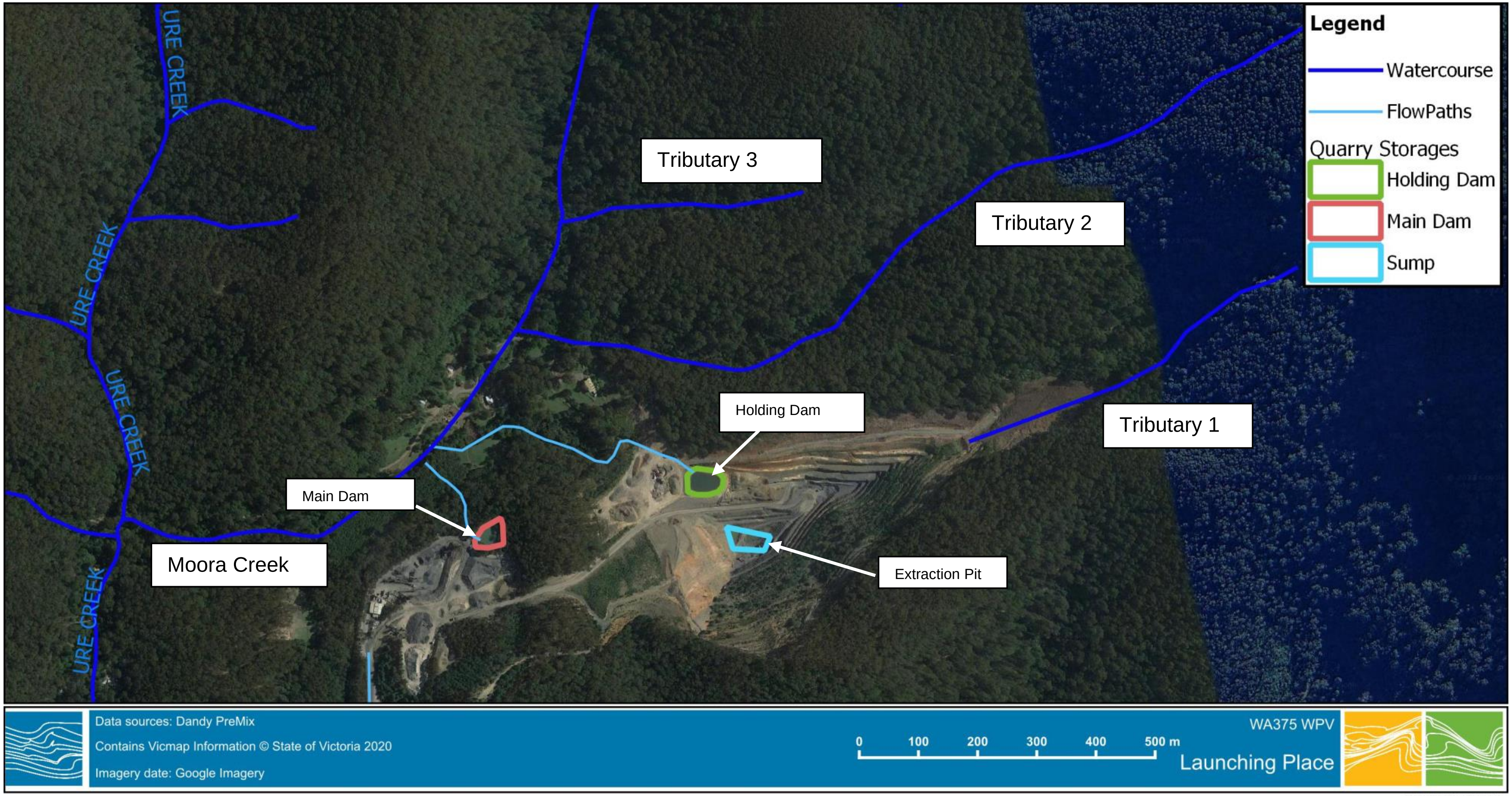

Figure 3-2 Surface Water Management

Figure 3-3 Left: Ure Creek downstream of McMahons Road Right: Moora Creek – adjacent to the site.

Figure 3-4 Left: Location of Tributary 1 inflow location (provided by YVQ). Right: Tributary 2 ~100m upstream of confluence to Moora Creek

4 DATA

The data collation assessed data availability within the study area, highlighting any shortfalls or gaps which were either filled or determined as minor enough not to impact project outcomes. The primary data required and collated for the surface water assessment included:

- High Resolution LiDAR.
- Satellite and aerial imagery.
- Rainfall data.
- Streamflow data (where appropriate).
- Spatial Land Use (planning zones, overlays, roads, land parcels).

4.1 Rainfall Analysis

Daily rainfall data was extracted from nearby Bureau of Meteorology (BoM) rainfall stations, located at Coranderrk (86219) about 5km north of the site, and Healesville (86229) 2.4 km west of the site. The former has continuous data from 1955 to 2015 and the latter has data available since 2007 to current day. A review of the available data was undertaken, and the two datasets were merged for use in the water balance modelling (discussed in Section 5).

Figure 4-1 BOM rainfall stations

Analysis of the period of rainfall dataset overlap showed daily rainfall totals are consistently higher at Coranderrk compared to the totals recorded at Healesville. Annual totals were 30% higher on average at Coranderrk between 2007 and 2015. The datasets were merged to produce a continuous series of daily rainfall records between 1955 and 2020 where the Coranderrk data was used from 1995-2007 and the Healesville data was used from 2008 to current day. The mean annual rainfall from the merged data was 1,189 mm.

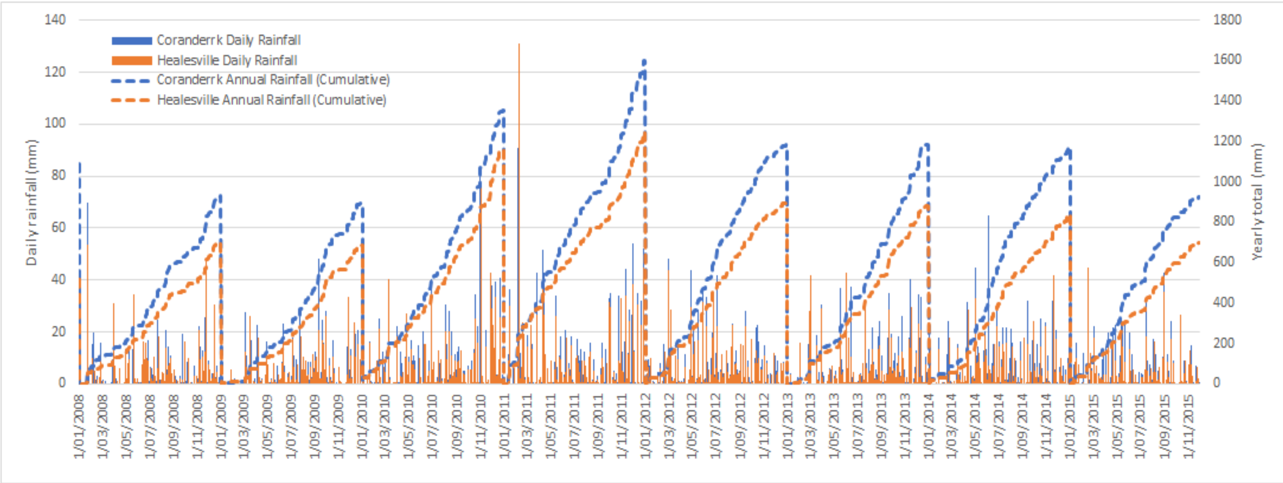

Figure 4-2 Daily rainfall at Coranderrk (86219) and Healesville (86229) stations (2007- 2015)

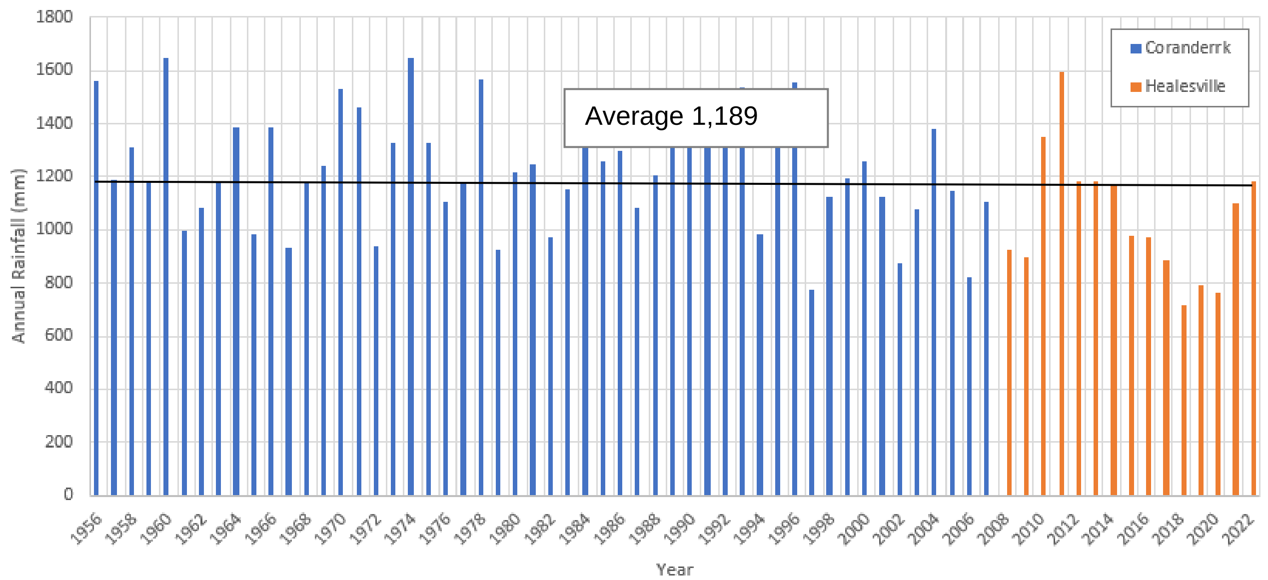

Figure 4-3 Merged Annual Series (Cumulative Rainfall)

Further analysis was conducted to compare the rainfall data provided by Dandy Premix Quarries from the site, with the data used in the model (gauge recorded rainfall data). As shown in Figure 4-4 and Figure 4-5, the two datasets have a higher correlation with R^2 value, 0.745, showing the rainfall recorded at the site is generally inline with the gauged data; however, the site data generally records lower rainfall compared to the nearby gauge.

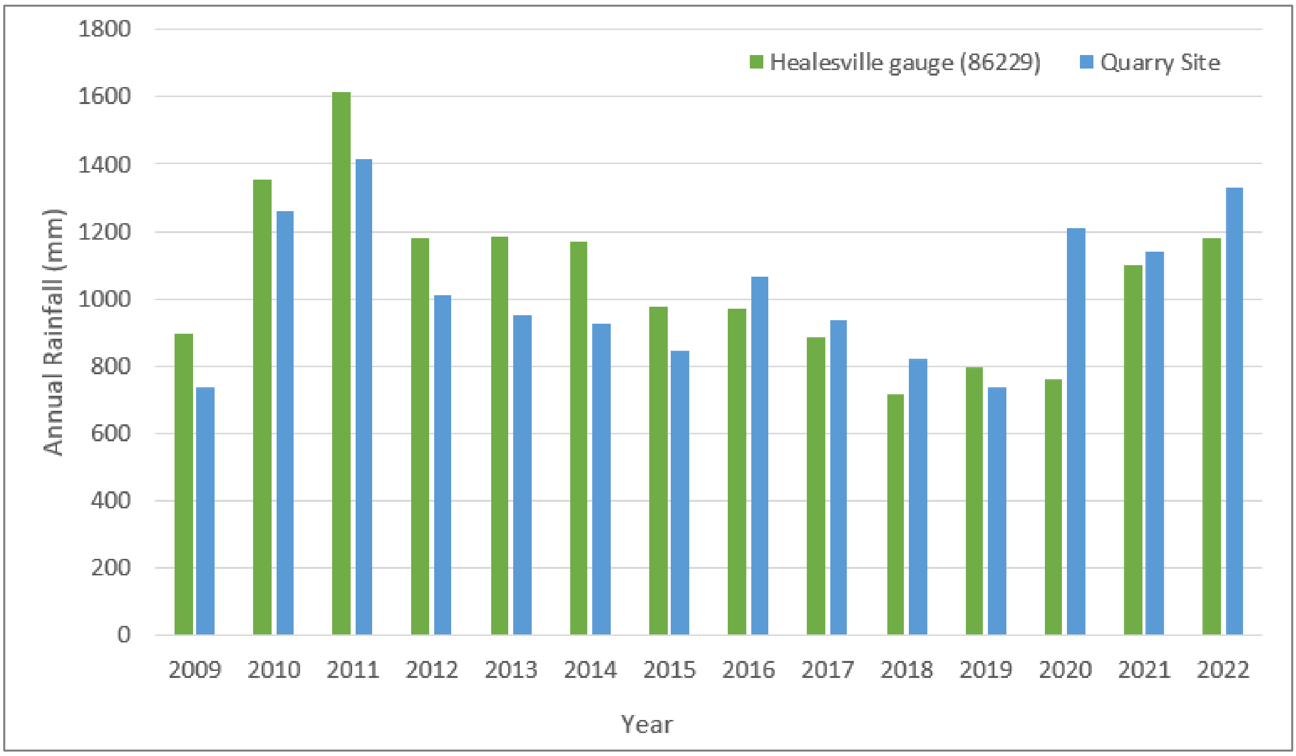

Figure 4-4 Annual rainfall recorded at the gauging station and the site

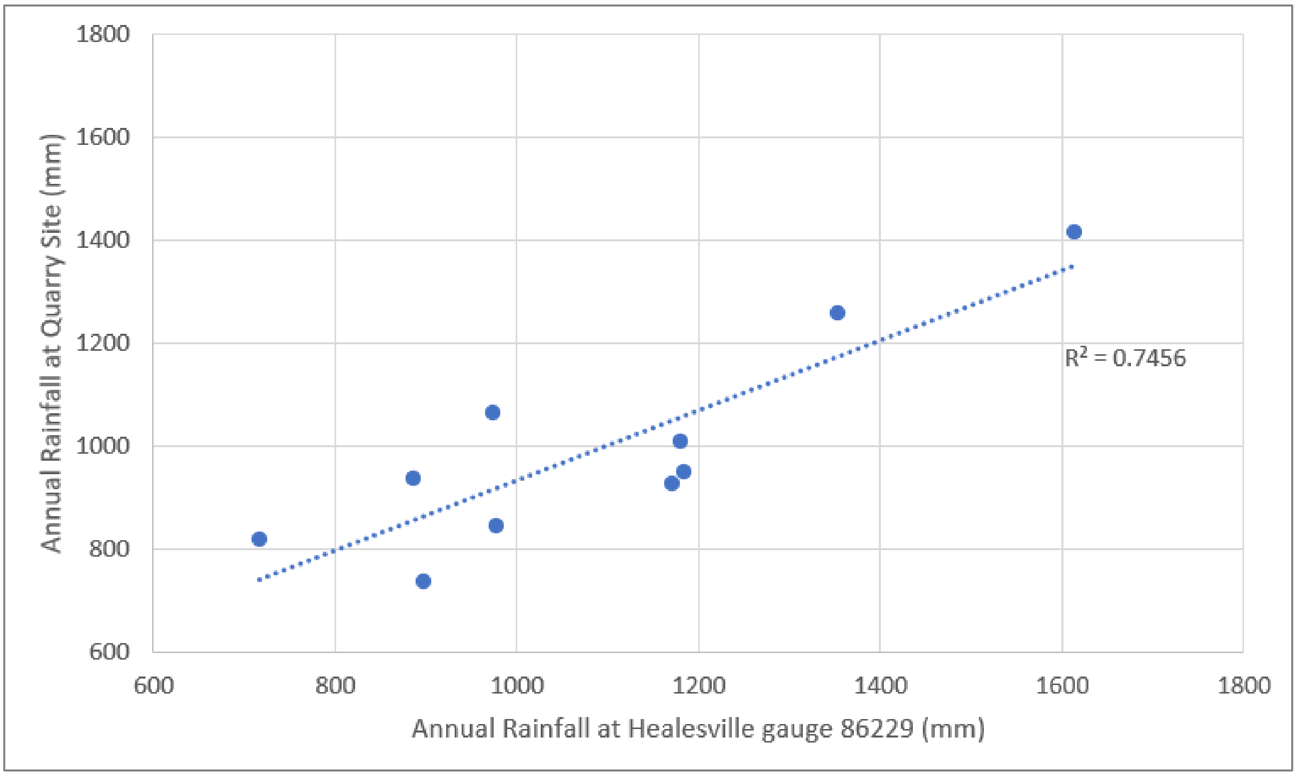

Figure 4-5 Comparison of annual rainfall between Healesville gauge and site

4.2 Streamflow, Height, and Quality Data

There were no active streamflow, height, or water quality gauges within the Works Area or Ure Creek catchment, with the catchment ungauged. However, there were several gauges in its proximity, further downstream on the receiving Yarra River, as well as in the nearby Hoddles Creek, which provided a guide for potential streamflow. Gauges in proximity to the Works Area are shown in Figure 4-6 these were:

- Don River – Launching Place (229220)*.
- Don River – Dalry Road Don Valley (229220B)*.
- Hoddles Creek at Launching Place (229224A)
- Yarra River – Launching Place (229226).

* Rating curves lacked quality at high flows

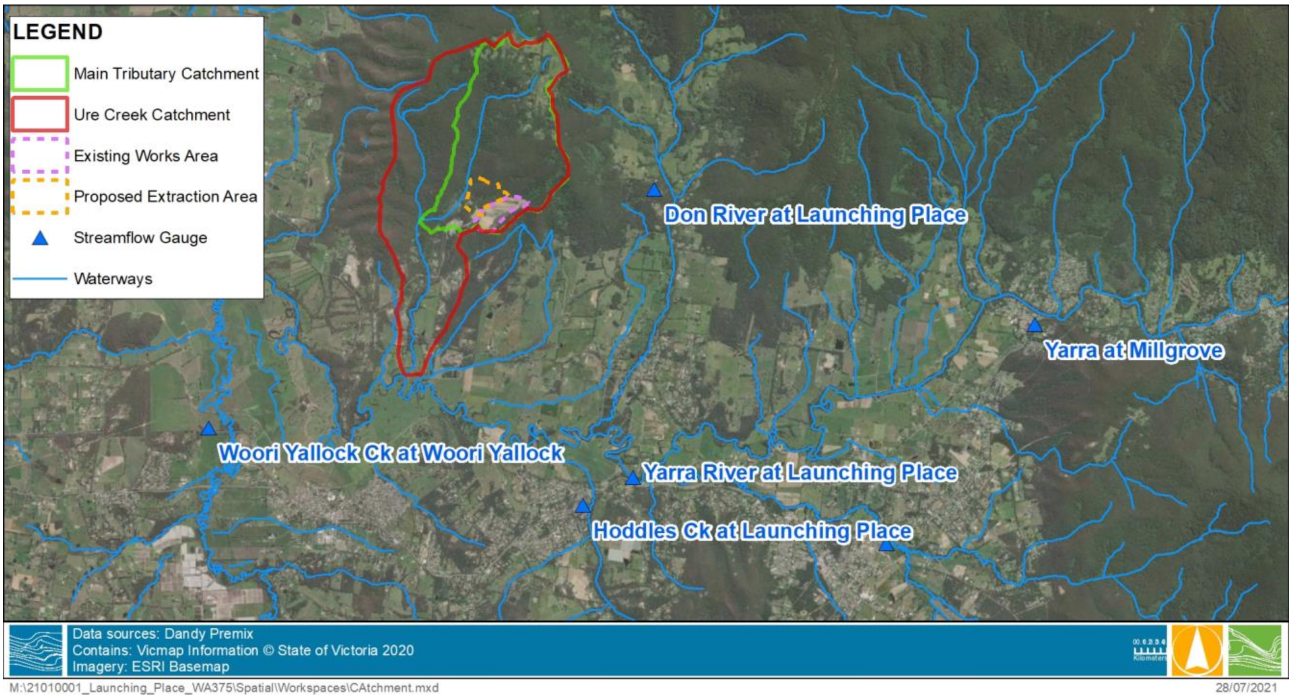

Figure 4-6 Nearby Streamflow Gauges

4.3 Evapotranspiration Data

Daily evapotranspiration data was based on average monthly evaporation extracted for each month of the year from the L-AWRA model at the site location. The monthly average applied to the model is presented in Figure 4-7.

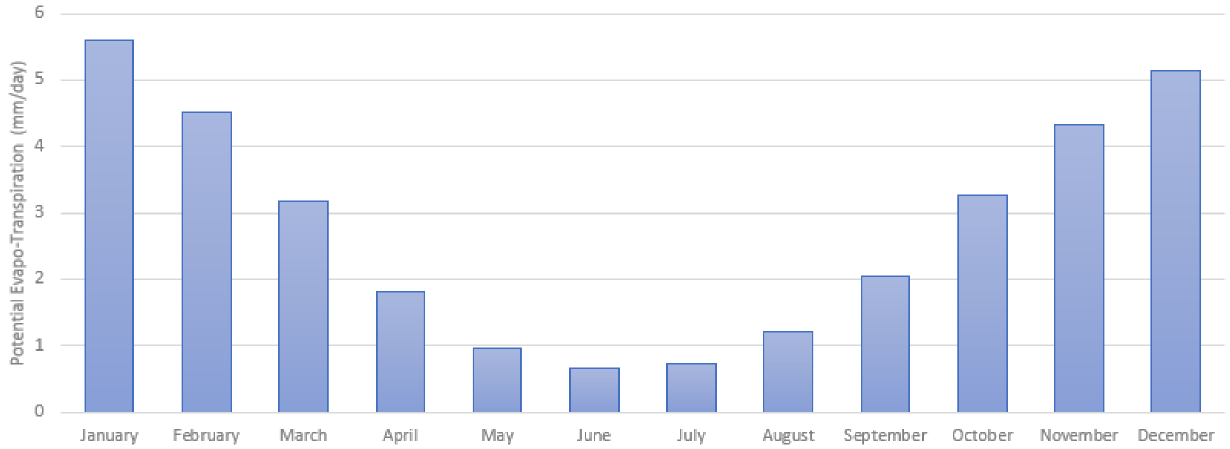

Figure 4-7 Average monthly evapotranspiration at the site

4.4 Topography

Topographic LiDAR data across the site and broader catchment was available from a range of sources. A LiDAR dataset covering the study area with a 1m resolution, captured in 2016 as part of the DEECA (formerly DELWP) Central Highlands LiDAR Project was selected to represent the terrain of the area for modelling baseline purposes.

For the proposed expansion scenarios, a Digital Elevation Model (DEM) was provided for the four scenarios (outlined in Figure 2-1) developed by BCA Consulting in conjunction with GHD. The DEMs were used to develop stage-storage relationships for the quarry pits and ultimate lake in the rehabilitation scenario. These scenarios and associated DEMs are shown in Figure 6-4 - Figure 6-6.

4.5 Quarry Water Consumption

The YVQ Quarry Manager provided the following information (Table 4-1) on the pumping rates at the quarry (estimated average for the previous 12 months) which have been adopted as indicative usage rates. These volumes and rates relate to management of surface water from the pit to the Main Dam and Holding Dam near the operation facilities.

Table 4-1 Quarry Water Consumption and Pumping Rates

Pumped Water from pit	
Pump Size	125x80 -400
Total Head (m)	48
Estimated flow rate (L/s)	20
Pump usage last 12 months (hours)	1560
Total estimated water pumped (L)	112,320,000
Total estimated water pumped (m^3)	112,320
Pumped water from Holding Dam	
Pump size	125x100 -200
Total head (m)	4
Estimated flow rate (L/s)	40
Pump usage last 12 months (hours)	73
Total estimated water pumped (L)	10,512,000
Total estimated water pumped (m^3)	10,512
Summary	
Total water pumped from pit (L)	112,320,000
Total water used on site (L)	10,512,000
Total water discharged off site (L)	101,808,000

4.6 Water Quality Sampling

Yarra Valley Quarries have provided surface water, rainfall and groundwater monitoring from 13 sets of laboratory analysis results dating from 2010 through to 2019, however all locations were not sampled during each set of sampling. Additionally, data was collected over the past 14 months from five surface water locations (Figure 4-11).

A summary of the water quality results for four locations is provided below for Nitrogen, Phosphorus and Total Suspended Solids (Figure 4-8 - Figure 4-10). Appendix A provides the tabulated results from each location.

- Moora Creek upstream of quarry outlet
- Moora Creek downstream of quarry outlet
- Settling Dam (sump at base of Extraction Pit)
- Main Dam

The results show that typically, the default triggers are not exceeded; however, there is one sample (27/03/2014) that shows high levels of TSS and Phosphate in the downstream waterway. Overall there is no clear trend indicating an increase in nutrient loads or TSS from upstream of the quarry pit to downstream.

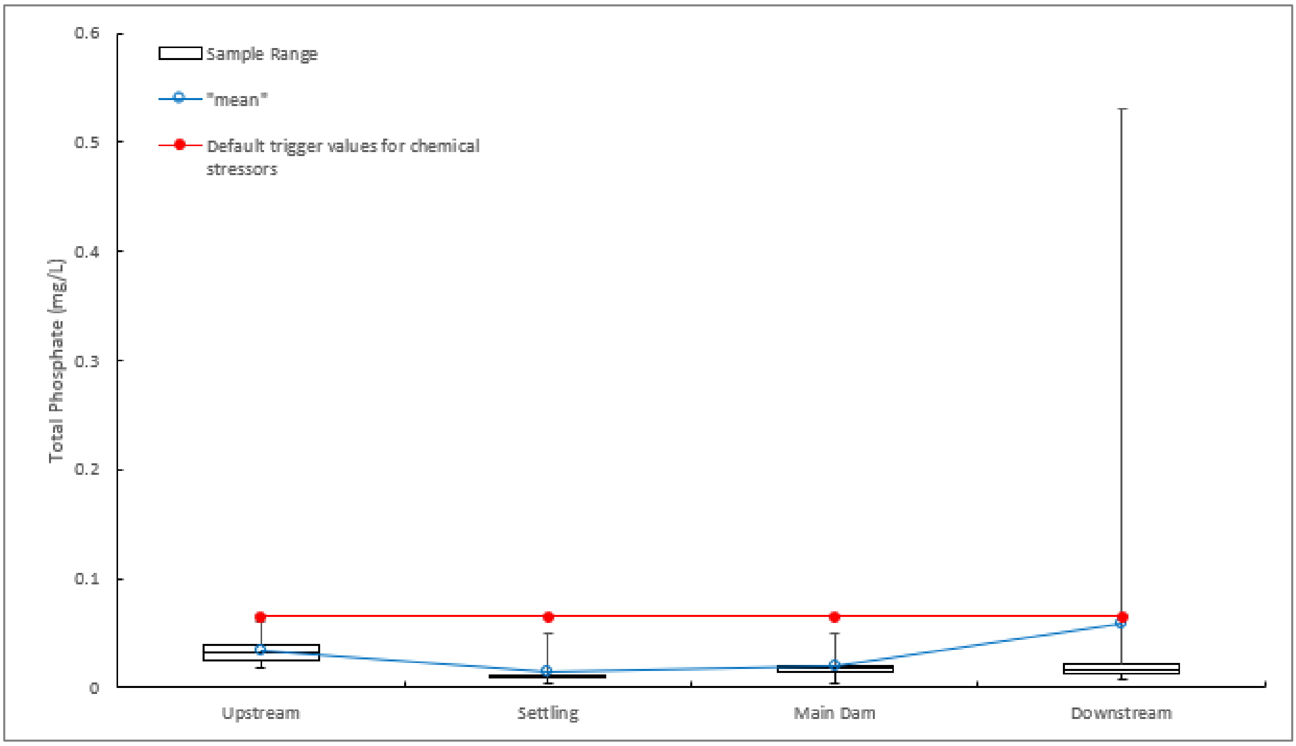

Figure 4-8 Phosphate

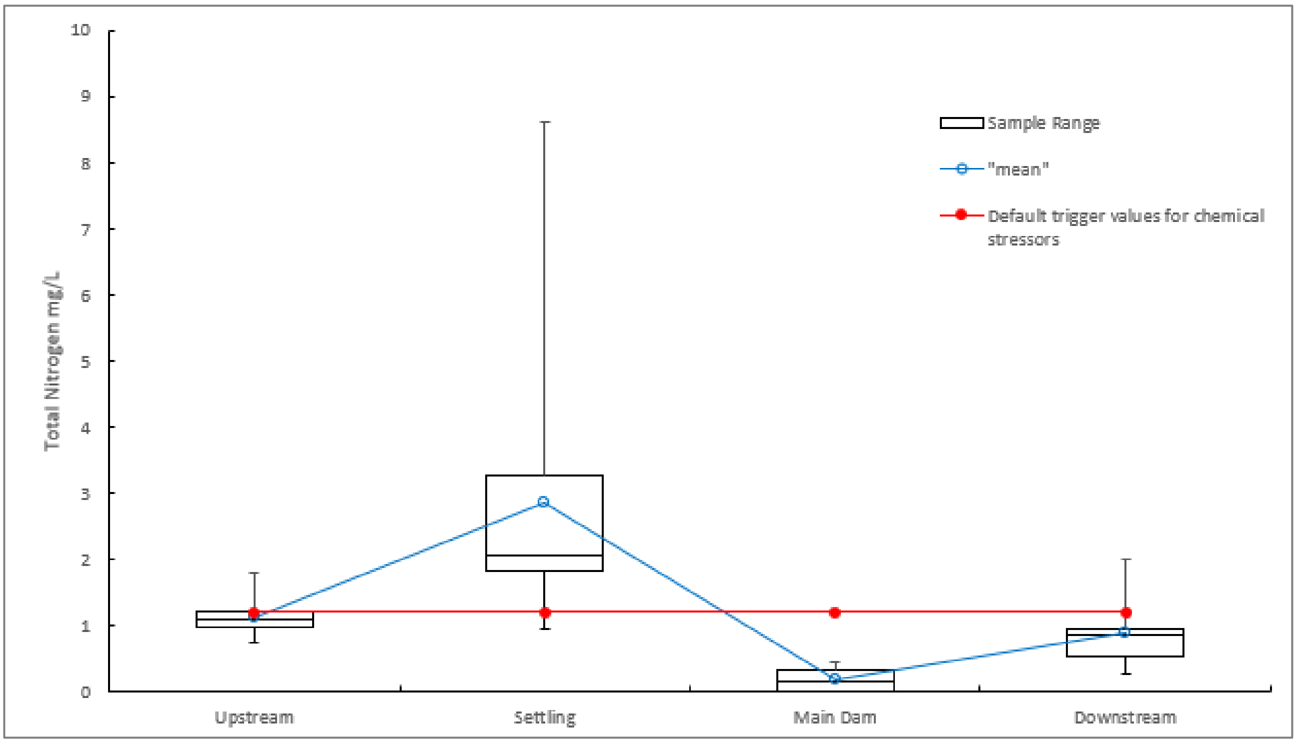

Figure 4-9 Total Nitrogen

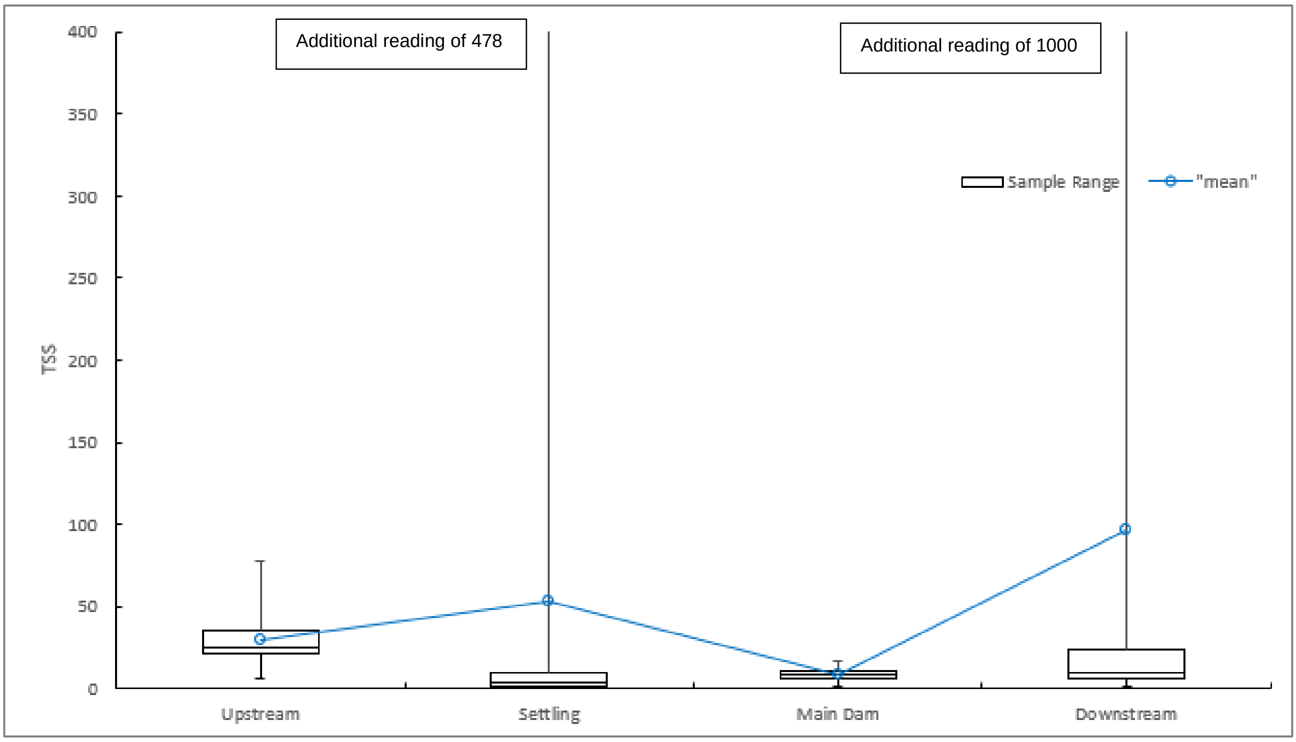

Figure 4-10 Total Suspended Solids

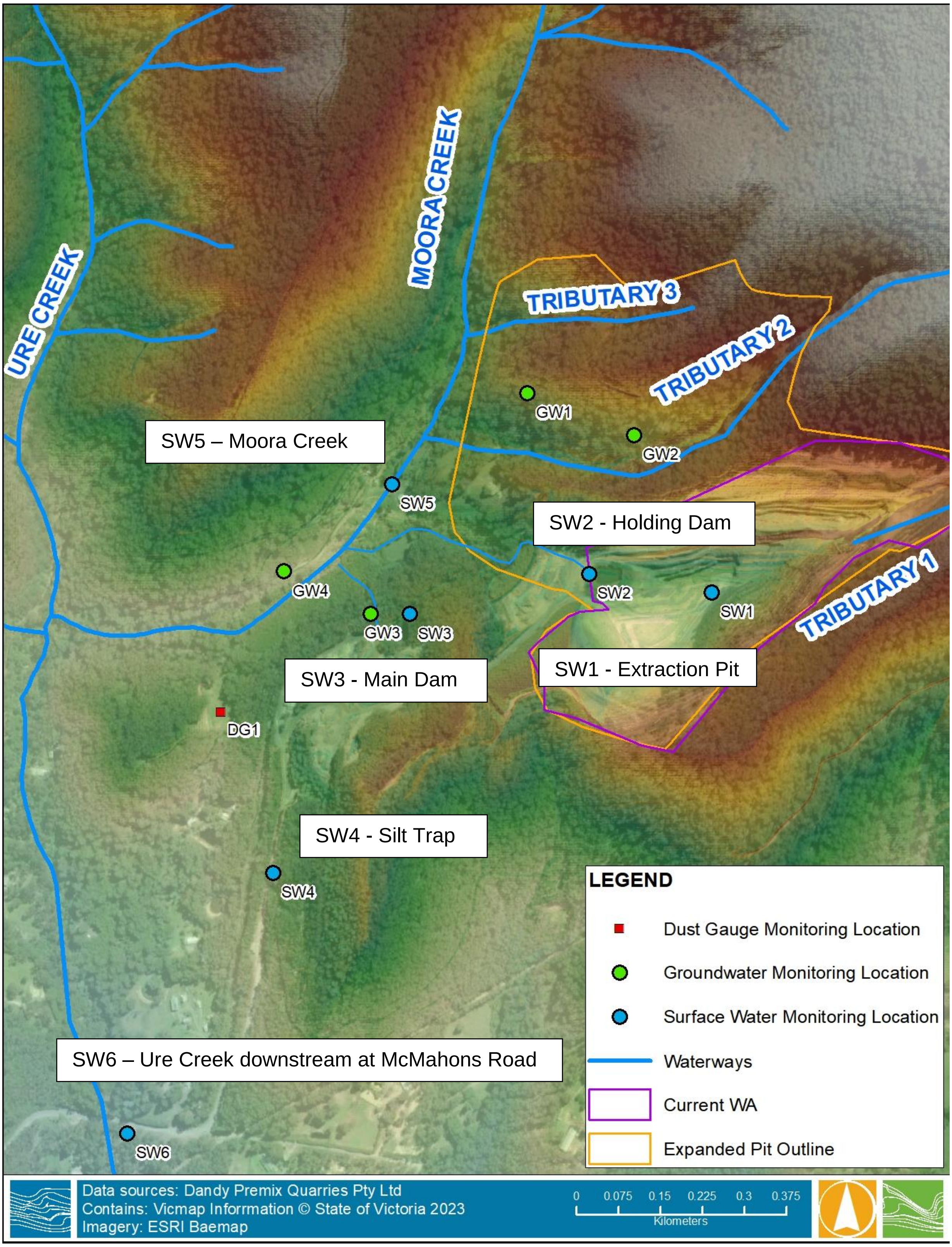

Figure 4-11 Water Quality Monitoring Locations

5 CURRENT WATER MANAGEMENT

There are three main water bodies currently located within the works area as shown in Figure 3-2:

- Extraction Pit/Sump.
- Holding Dam.
- Main Dam.

Currently, the Extraction Pit captures surface water runoff directly from the pit as well as from the upstream catchment that has been intercepted by the pit. Water settles in the pit sump, but for operation of the quarry, water is pumped to the upper level Holding Dam adjacent to the pit, which also functions as a further settlement pond.

The quarry water cart is filled from the Holding Dam as the primary source of water used for dust suppression of haul roads, the crushing and stockpile pad traffic areas and other vehicle access roads, including the sealed quarry access road, from McMahons Road. Higher seasonal inflows that exceed the fill capacity of the Holding Dam are discharged in a south-west direction, via an installed 300 mm discharge pipe to Moora Creek within adjoining Dandy Premix land known as Lot 49A.

Moora Creek is the major tributary of Ure Creek, with their confluence approximately 700 metres further south-west in Lot 49A. Moora Creek receives inflows from several smaller tributaries and gully catchments in the upper reaches of Lot 49A, and from several catchments in the proposed quarry expansion area of Lot 50C (Tributary 2 & Tributary 3).

The 'Main Dam' receives surface water inflows from the vegetated patch to its elevated north-east and the northern extent of the sales loading and stockpiles pad area. Water stored in the Main Dam is piped to service the spray-bar dust suppression equipment installed on the primary and secondary crushing plant operations, including product conveyors and the sales loader concrete aggregates stockpiles.

Any surplus surface water captured in the Main Dam is discharged via a spillway pipe to Tributary 1 in Lot 49A to its west, which receives overflow discharges from the Holding Dam. As previously outlined, Tributary 1 joins Moora Creek and thereafter, Ure Creek. The estimated capacity of the two dams is around 15 ML.

Surface water runoff from the main access road and weigh bridge station area is discharged from the site into Ure Creek at McMahons Road, via the existing concrete lined drain on the east verge of the main access road. Water discharged off site leaves the eastern roadside drain via a rock and concrete lined drain along McMahons Road and enters Ure Creek on the southern side of the road.

The management of surface water runoff on the site appears consistent with that as described in Craigie 2009[1].

"The main objective of the water management system is to store, treat and discharge runoff generated from within the site in a way that mitigates detrimental impacts offsite and ensures that water movement within the work area minimises interference with quarry operations."

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[1] Proposed Extension to Hard Rock Quarry McMahons Road, Launching Place - Drainage And Water Quality Management, prepared by Neil Craigie for Dandy Premix Pty Ltd t/a Yarra Valley Quarries, July 2009.

5.1 Drainage Mitigation Investigation

As part of the 2021 drainage investigation, a series of mitigation options were assessed to deal with changes to the hydrological regime from the quarry expansion into Lot 50C.

Options to capture upstream catchment flows from Tributary 2 and Tributary 3 prior to entering the pit and diverting around the pit as well were investigated. Further to this, the reinstatement of Tributary 1 through the rehabilitation and revegetation of the existing Extraction Pit were explored. These options would require significant earthworks and do not appear feasible from a hydraulic perspective (i.e. there is insufficient fall/grade along the diversion alignment for this option to be feasible). They would also require the removal of additional native vegetation along the diversion alignment as well as construction access.

Pumping of flows from the Extraction Pit to match the existing hydrological regime is not a viable solution from an operational perspective. The size of the pumps required to maintain the hydrological regime (flow into the pit equal to flow out of the pit) is impractical during large storm events as well. There also would be requirements to store and treat runoff which has been generated within or has entered the pit from the upstream catchment to ensure suitable water quality leaving the site. This would require a change to the current operating procedure of the settling of inflows within the Extraction Pit sump and again in the Holding Dam.

Following these findings, the current study has identified a stormwater management system for the proposed expansion similar to the approach that is has been employed at the WA375 site since 2009.

6 WATER BALANCE MODELLING

6.1.1 Overview

A detailed Water Balance model was developed to investigate the impact of the proposed WA375expansion on the downstream waterway as well as to investigate potential changes to discharge rates from the quarry as the expansion crosses multiple catchments.

The eWater Source application was used to develop a water balance model for five different scenarios. Source is a hydrological modelling platform which integrates water resource assessment tool used for undertaking technical assessment of water balances for catchments, mining and agricultural purposes. Source includes a range of rainfall runoff models that allow or the calibration of models to existing streamflow data.

This modelling utilised rainfall (1955-2020) from the BoM, verified against daily rainfall at the site since 2009 and monthly evapotranspiration data averaged to a daily scale. The Australian Water Balance Model (AWBM) was used to estimate the flow generated from each sub-catchment based on the applied climatic data (rainfall and evapotranspiration). The base model was calibrated using eWater Rainfall Runoff Library (RRL) tool kit for the nearby Hoddles Creek catchment, which had a streamflow gauging station record extending back to 2003. The parameters adopted in the calibration were then applied for the study catchment.

6.2 Model structure

Schematisation of the Source model is shown in Figure 6-1, with the current WA375 Extraction Pit (red polygon) and proposed Extraction Pit expansion (green polygon). The Source model components are described below:

- Node: represents catchments and calculates joined flows based on rainfall and upstream rainfall runoff.
- Link: connect and convey flows between nodes.
- Sub-catchment: catchment rainfall and runoff are recoded and contribute to downstream nodes through links. Data inputs include catchment area, historical rainfall, and evapotranspiration.
- Storage: the storages represent a reservoir in the model. It utilises of several sets of data, including rainfall, evapotranspiration, seepage rate and a stage-volume curve. In this model reservoirs represent the Extraction Pit and water storage dams (Main Dam and Holding Dam).
- Minimum flow requirement: the node that extracts certain amount of flow from storages if there is enough volume to meet the requirement. It represents the water used for mining operations in this project.

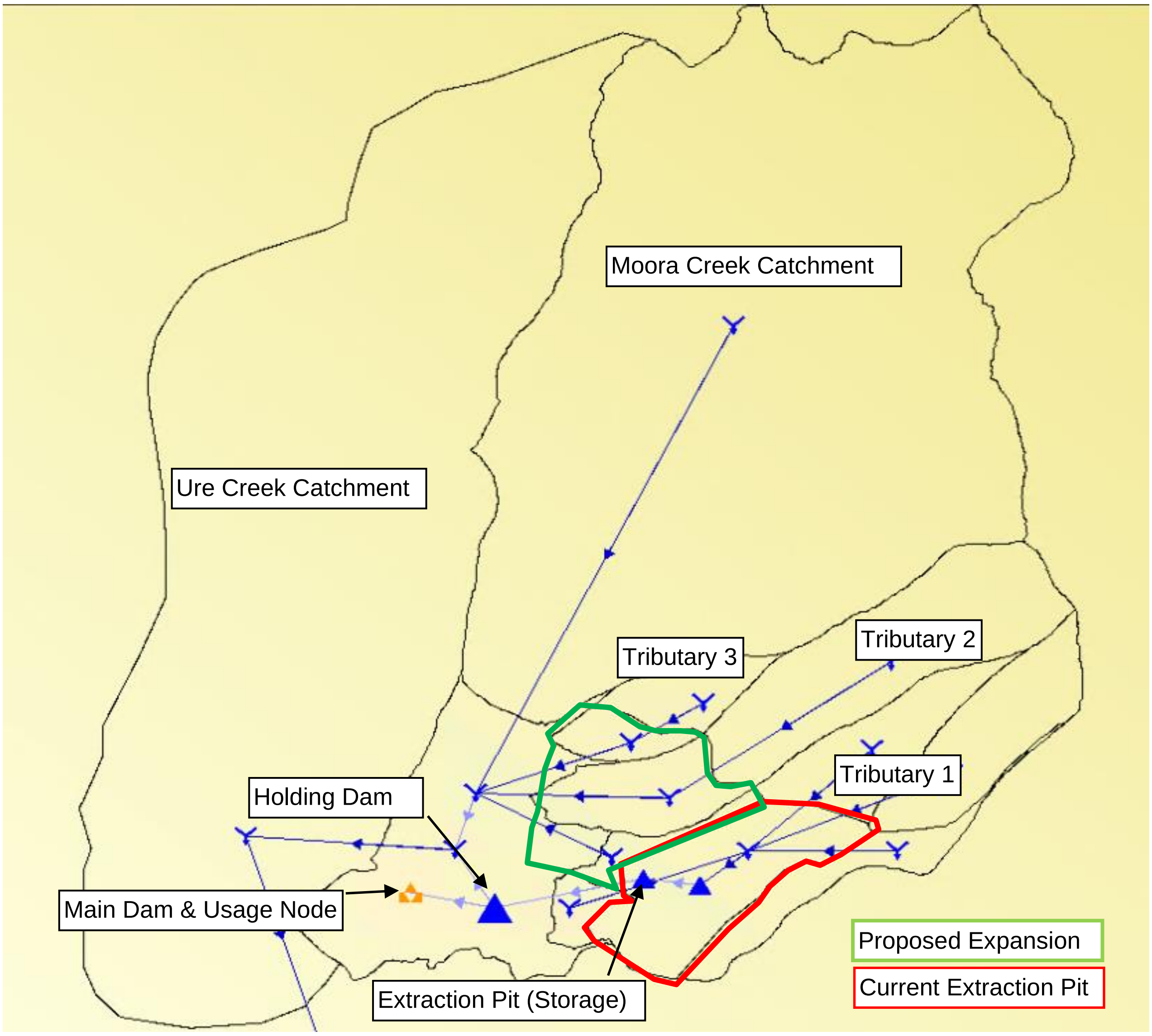

Figure 6-1 Source Model Structure

The WA375 current Extraction Pit intercepts a single tributary of Moora Creek (Tributary 1). The proposed expansion into Lot 50C will intercept an additional two tributaries (Tributary 2 and Tributary 3). Under pre-quarry (referred to as natural conditions) and existing conditions, these sub catchments drain into Moora Creek to the west of the quarry which ultimately flows to Ure Creek. To provide comparison between the existing and proposed expansion scenarios in the Source model, the main catchments were divided into smaller sub-catchments. In the proposed expansion scenarios, sub-catchments located within and upstream of the site were redirected to convey flow into the pit and managed through pump and release scenarios.

Key locations used for daily and annual assessment in the water balance model are shown in Figure 6-2.

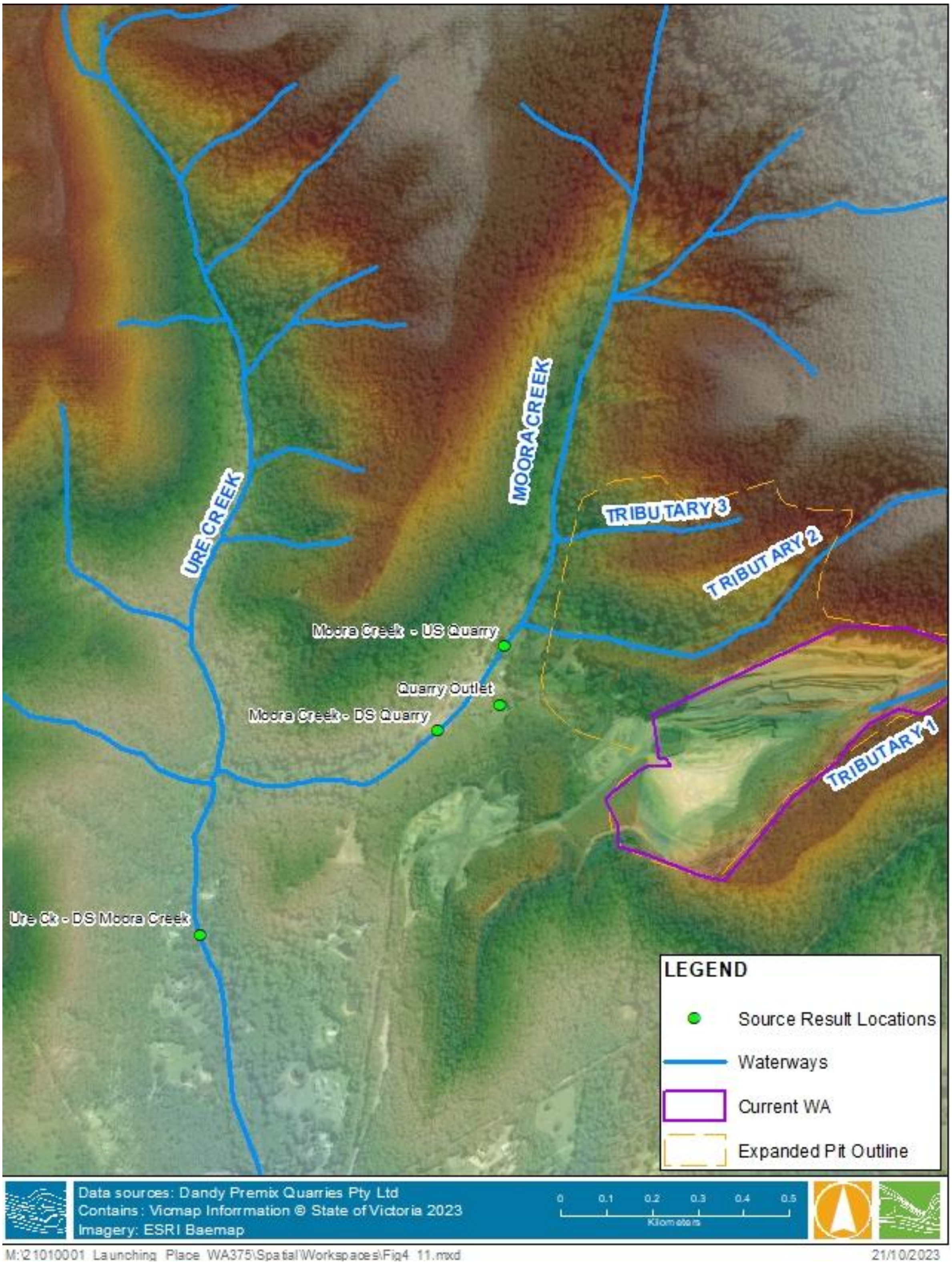

Figure 6-2 Source Result Processing Locations

6.2.1 Model Input data

The Source model contained the following inputs:

- Rainfall – Daily rainfall data was used based on nearby gauges.
- Evapotranspiration – Daily potential evapotranspiration was incorporated into the Source model based on average monthly evaporation, extracted for each month of the year from the L-AWRA model at the site location and was used for the modelling. The monthly average applied to the model is presented in Figure 4-7.
- Hydrogeology - Groundwater analysis undertaken by John Leonard Consulting Services (JLCS). It is noted that this water balance assessment has not attempted to quantify groundwater-surface water interaction within the model due to the complexities involved.

6.2.2 Model Scenarios

For various stages of the quarry expansion, the model was revised to reflect the changing catchment and quarry conditions. Comparisons between different scenarios were used to understand the impact of the development on catchment water balance.

The following five model scenarios were tested.

- Natural Conditions (prior to quarrying).
- Existing Conditions (current quarry).
- Hydrology Expansion Phase 1 - Expansion once first drainage line is intercepted (Stage 1 – discussed in Section 1.2).
- Hydrology Expansion Phase 2 - Expansion once second drainage line is intercepted (Stage 2 & 3 – discussed in Section 1.2).
- Final Pit Void – Rehabilitation and revegetation post quarrying.

DEMs were produced by BCA Consulting for each proposed mining operation stage. DEM layers showing the progression of the quarry through the proposed expansion and location of the intersecting tributaries are illustrated in Figure 6-4 - Figure 6-6.

For the existing and proposed scenarios, the Source model used a Minimum Flow Requirement node and a value from the Holding Dam to indicate the site water consumption. In the existing conditions scenario water usage was modelled as 10 ML/year, while future development scenarios modelled water usage as 20 ML/year (as a conservative assumption) to account for an increase in demand for processing and dust suppression, including the increased length of haul roads.

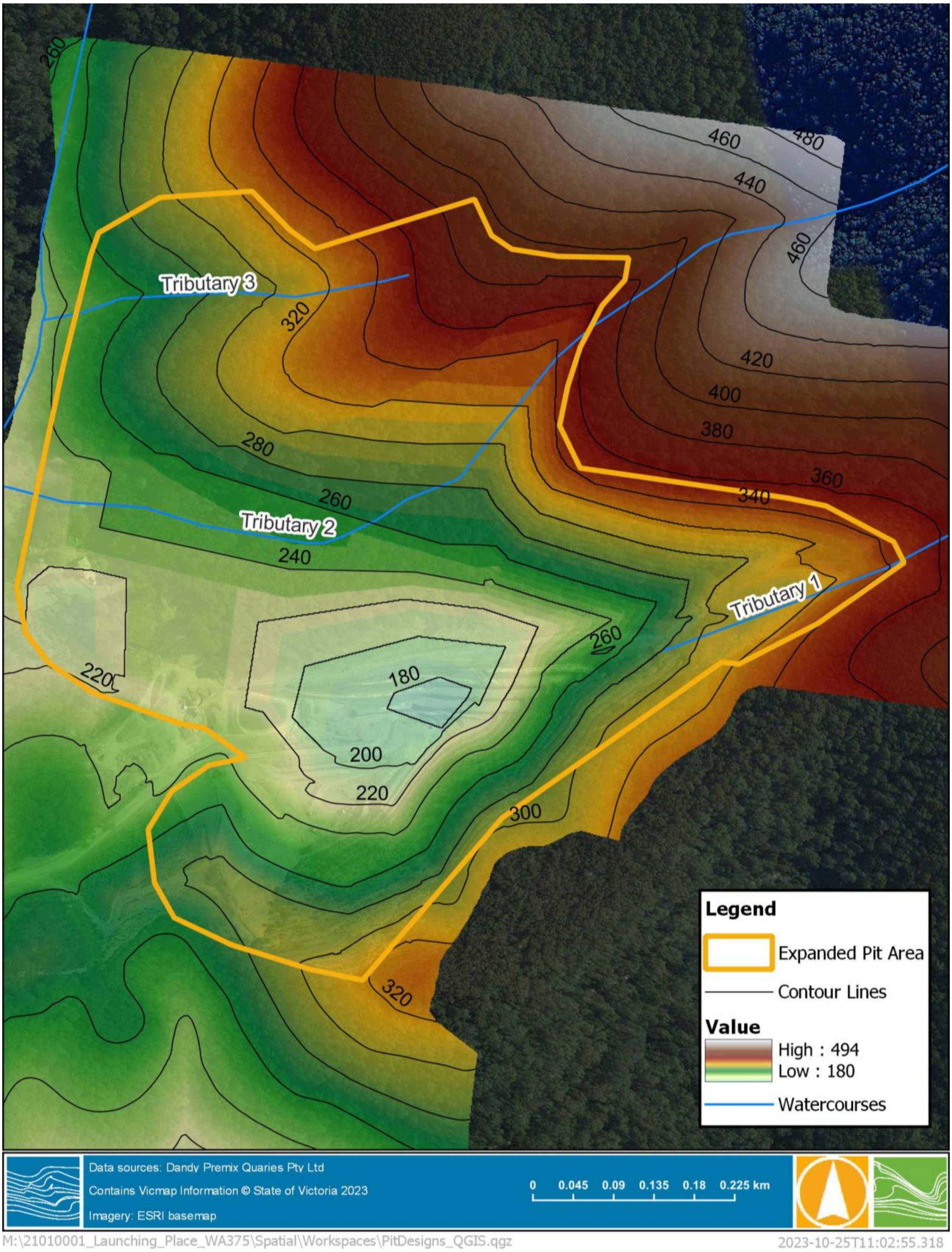

Figure 6-3 DEM plan - existing conditions

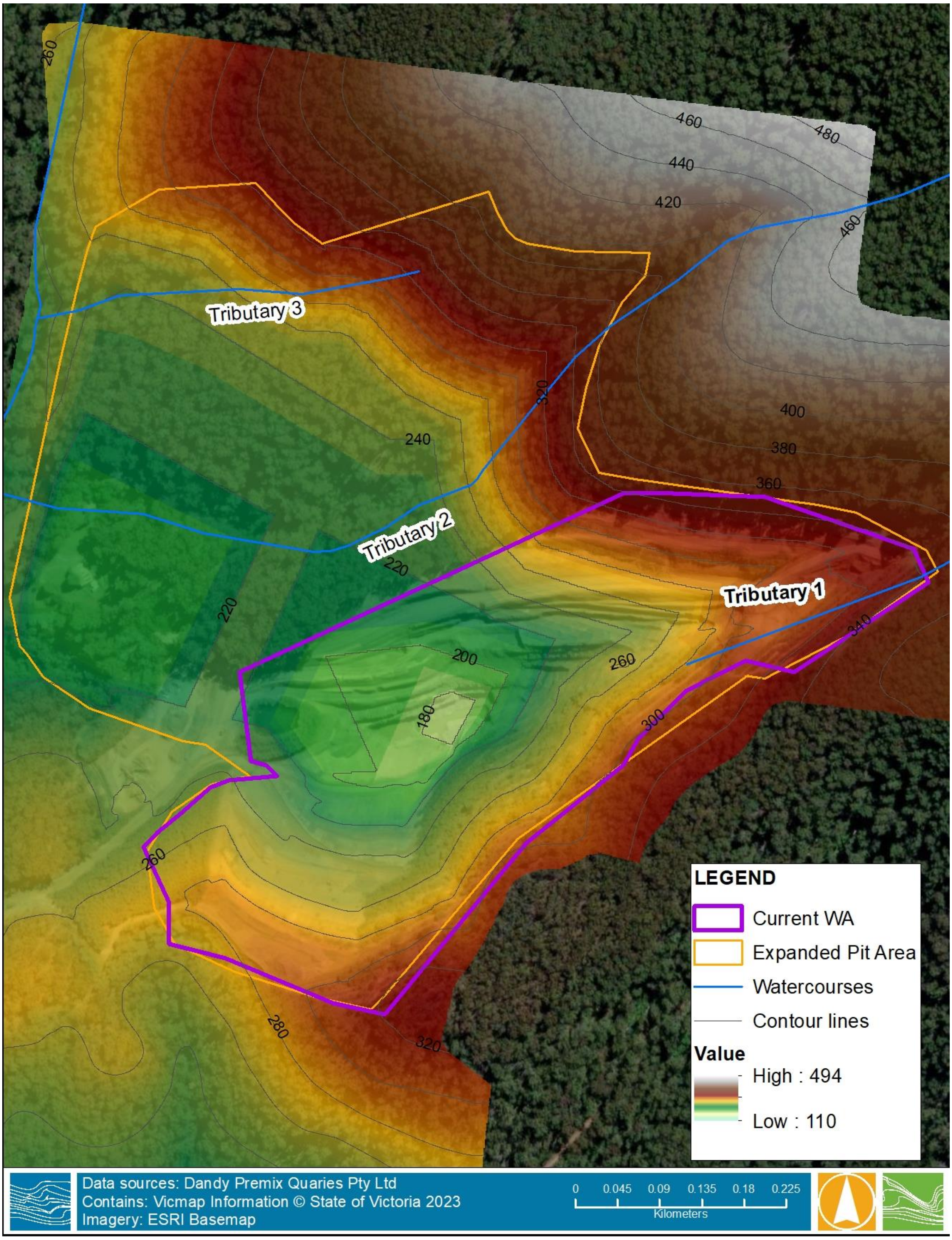

Figure 6-4 DEM plan for proposed expansion – Stage 1

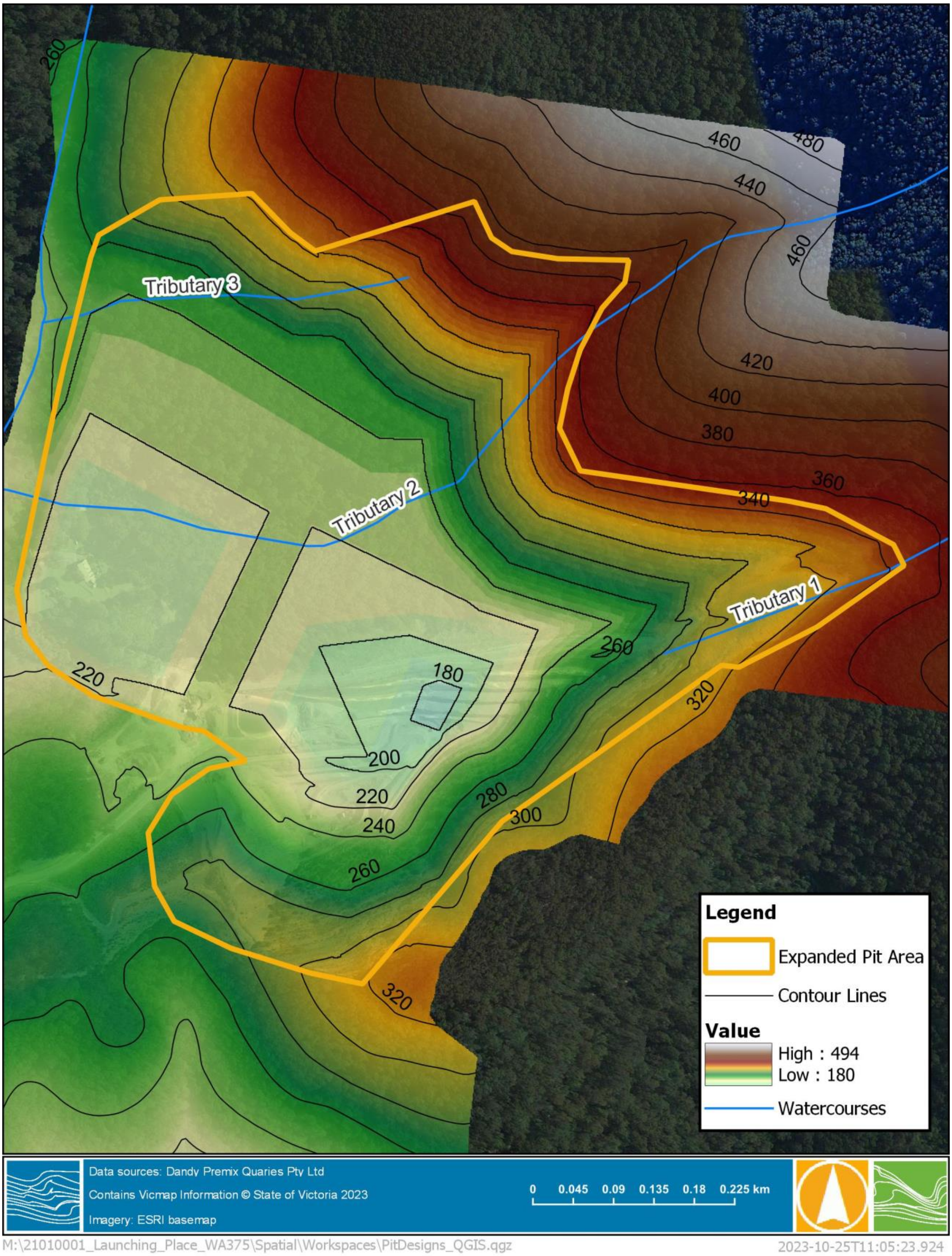

Figure 6-5 DEM plan for proposed expansion – Stage 2

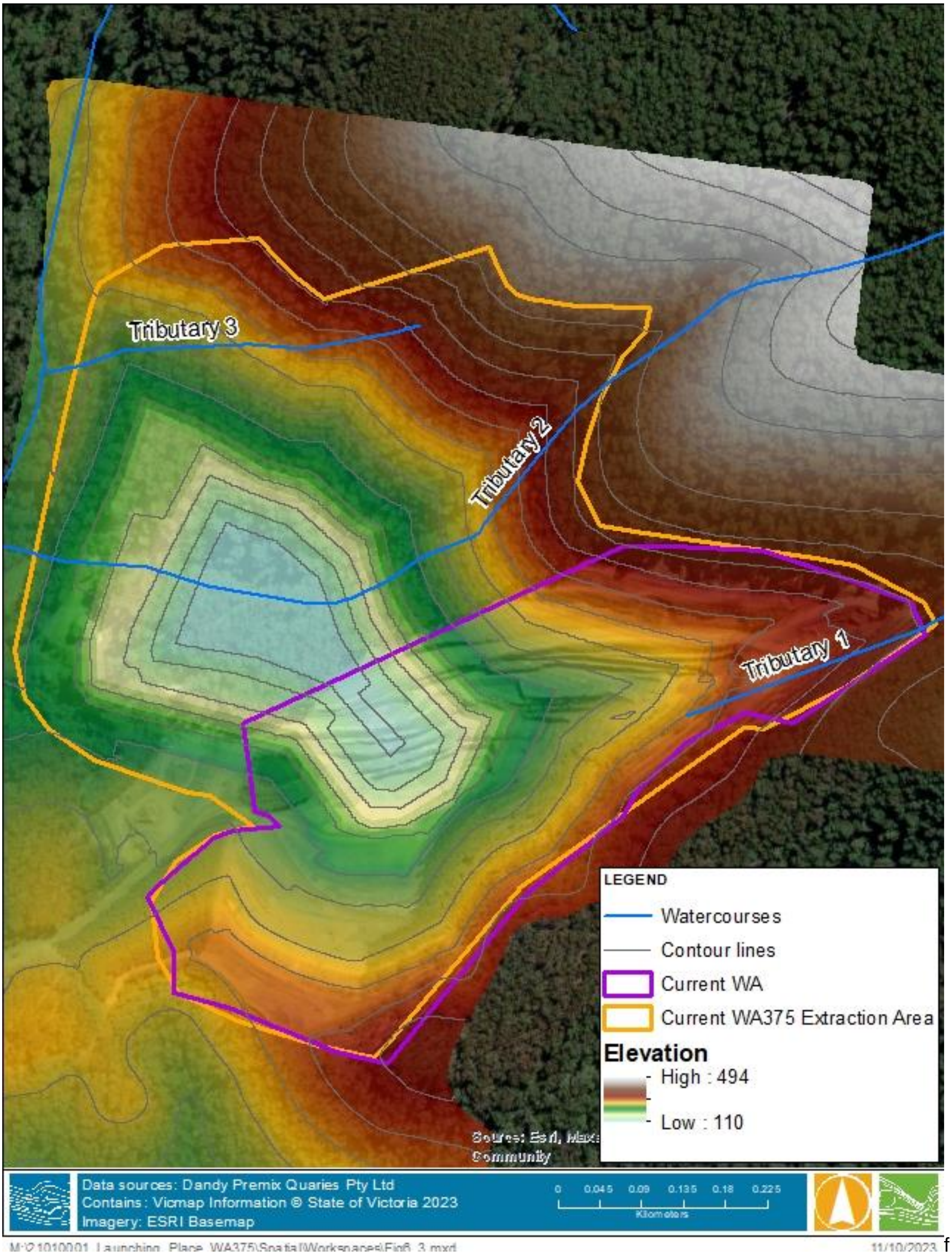

Figure 6-6 DEM plan for proposed expansion – Final Design

6.2.3 Rehabilitation Stage

Throughout the lifetime of the quarry the benched batter cuts will be progressively topsoiled and revegetated as has been the case to date with the existing quarry. Currently the rehabilitated landform plan includes the reinstatement of ‘natural’ flows along Moora Creek thence Ure Creek through the filling of the final Extraction Pit from the upstream catchments.

The Extraction Pit lake will have a spill level constructed at 217m AHD, above which flows will outfall west into Moora Creek as shown in Figure 6-7. Water table mapping by John Leonard Consulting Services[2] indicates that the water table in the area around WA375 would discharge into local creeks at lower elevations but cannot specify where. Certainly, the Yarra River and low spots across its floodplain, and probably along the lower reaches of Ure Creek, possibly near confluence with Moora Creek.

A recharge analysis by JLCS indicated that groundwater recharge into the outcropping Humevale Siltstone is low, less than 5% of rainfall (based on the Chloride Mass Balance method). From this, it was suggested that groundwater inflow to the Extraction Pit lake would be relatively small with the hydraulic conductivity of the Humevale Siltstone is expected to be relatively minimal, in the range of 0.001 to 0.01 m/day.

The water quality of the Extraction Pit lake will be determined by the rate and chemistry of groundwater flowing into the pit, runoff from the pit walls and upstream catchment and the time required for the pit to fill. This assessment has not investigated the chemistry of the water sources, but has reported on the existing surface water sampling results (Section 7).

[2] Hydrogeological Assessment, proposed extension, Yarra Valley hard rock quarry, McMahon Road, Launching Place, prepared by John Leonard Consulting Services

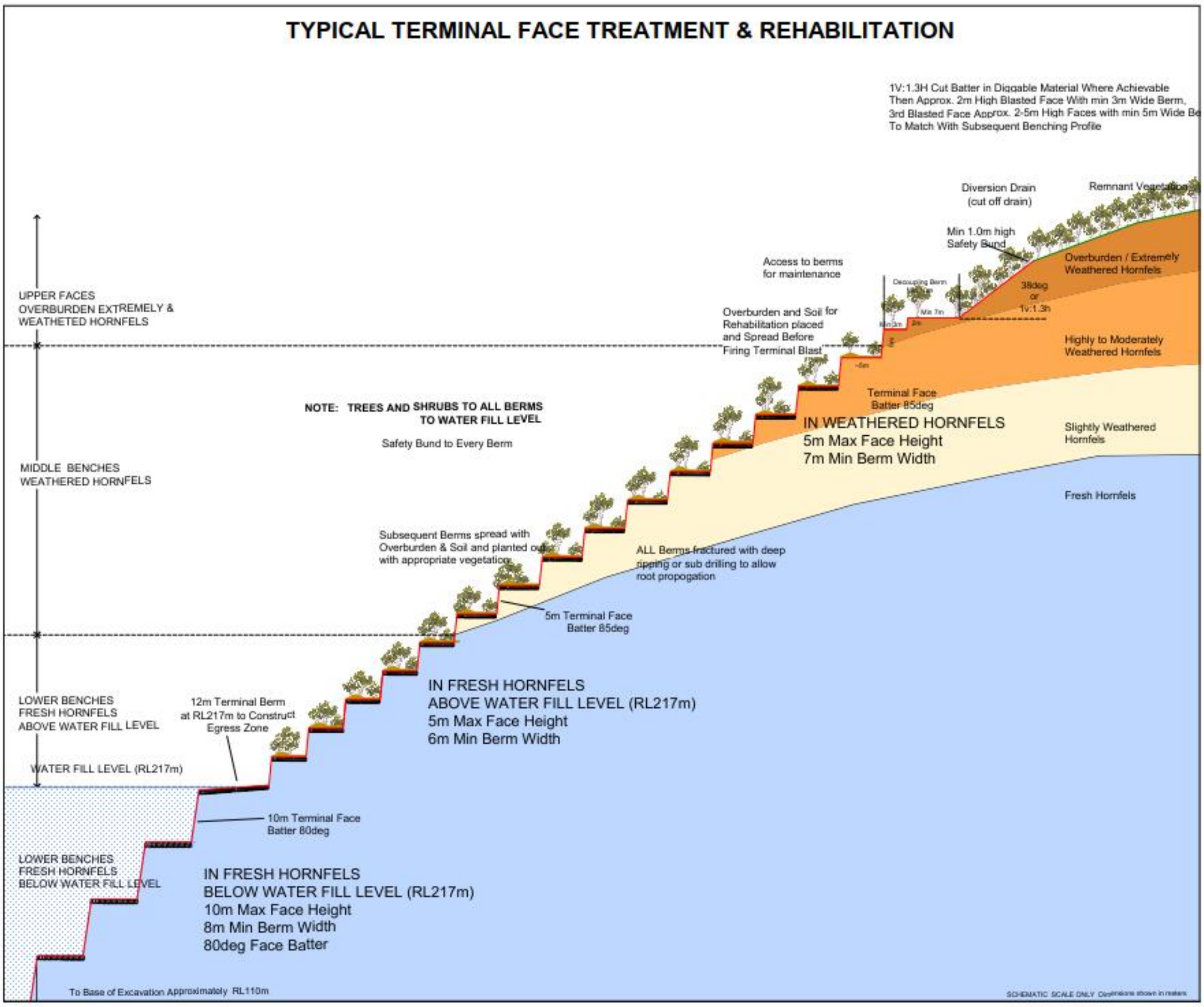

Figure 6-7 **Typical Terminal Face Treatment & Rehabilitation (Source: BCA Consulting)**

6.3 Model Calibration

As discussed in Section 6.1.1, the rainfall runoff model adopted in the Source software package was the AWBM, which estimates the flow generated from each sub catchment based on the applied climatic data (rainfall and evapotranspiration). Therefore, the model was calibrated for the nearby gauged catchment (Hoddles Creek) which has similar catchment characteristics to the expanded WA375 site (Launching Place) catchment and is the most appropriate catchment to establish calibration parameters (Figure 6-8).

The calibrated model AWBM parameters are shown in Table 6-1.

Figure 6-9 outlines the comparison of monthly flows between calculated and observed runoff, with a Nash-Sutcliffe Criterion (Coefficient of efficiency) value of 0.428, which is considered an acceptable model fit based on the trend of the modelled and recorded flow values. This shows the modelled volumes on a monthly basis are generally in line with observed volumes. When plotted at a daily scale, the calibration shows a good fit between modelled and gauged flow (Figure 6-11), which highlights the modelled flow follows the observed flow pattern with the exception of higher peak flows. Given the purpose of the water balance assessment is primarily focused on volumes and the replication of the natural hydrology regime of Ure Creek, the adopted model parameters were determined fit for purpose.

The AWBM model parameters used to represent the quarry areas were developed from previous Water Technology projects and our experience across numerous quarry projects. The main assumptions for the quarry areas (cleared for extraction) being a lower threshold of surface storage capacity and reduced baseflow as a result of less infiltration. This results in a higher proportion of runoff in the quarry areas that are cleared of vegetation for extraction and haul roads when compared with forested areas existing ground cover consisting of mature vegetation. This is also due to less interception and uptake of water in the soil from plants.

Table 6-1 AWBM Model Parameters

Parameter	Description	Forested Area	Quarry Area
A1	Partial Areas Represented by Surface Storages	0.104	0.2
A2	Partial Areas Represented by Surface Storages	0.433	0.6
KBase	Daily Baseflow Recession Constant	0.995	0.1
KSurf	Daily Surface Flow Recession Constant	0.774	0.1
BFI	Baseflow Index	0.11	0.01
C1	Surface Storage Capacities	20.1	5
C2	Surface Storage Capacities	167.0	70
C3	Surface Storage Capacities	410	90

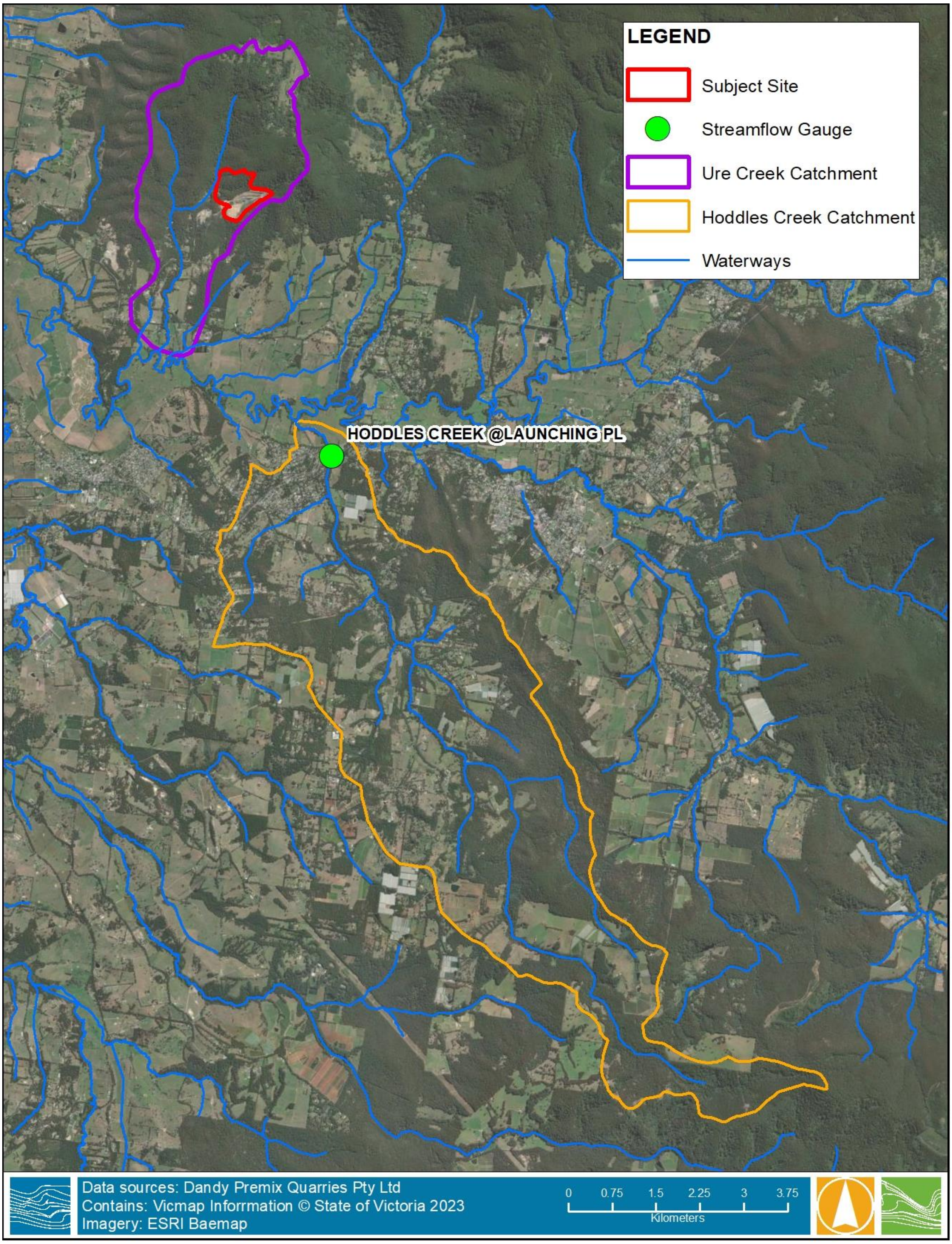

Figure 6-8 Location of Calibrated Hoddles Creek catchment

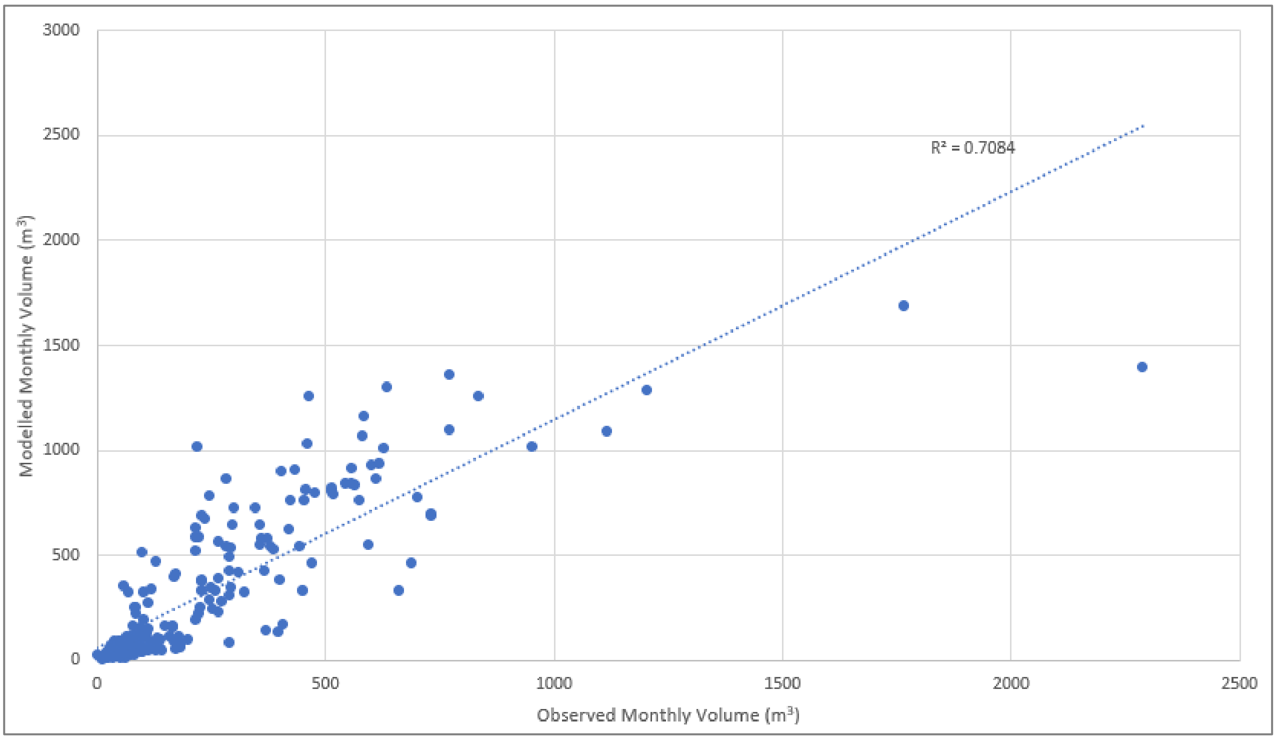

Figure 6-9 AWBM Model Calibration Results – Monthly Flow Volumes for the Hoddles Creek catchment

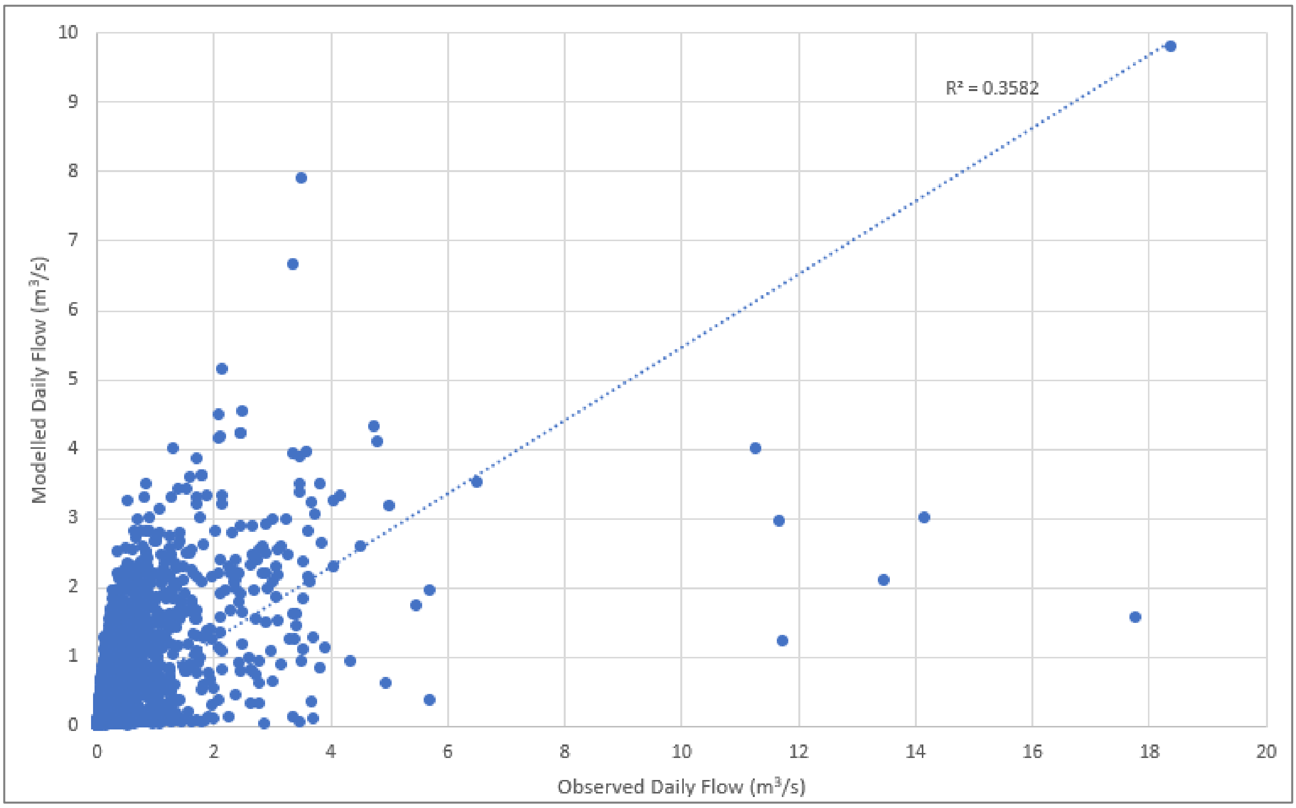

Figure 6-10 AWBM Model Calibration Results – Daily Peak Flow Comparison for the Hoddles Creek catchment

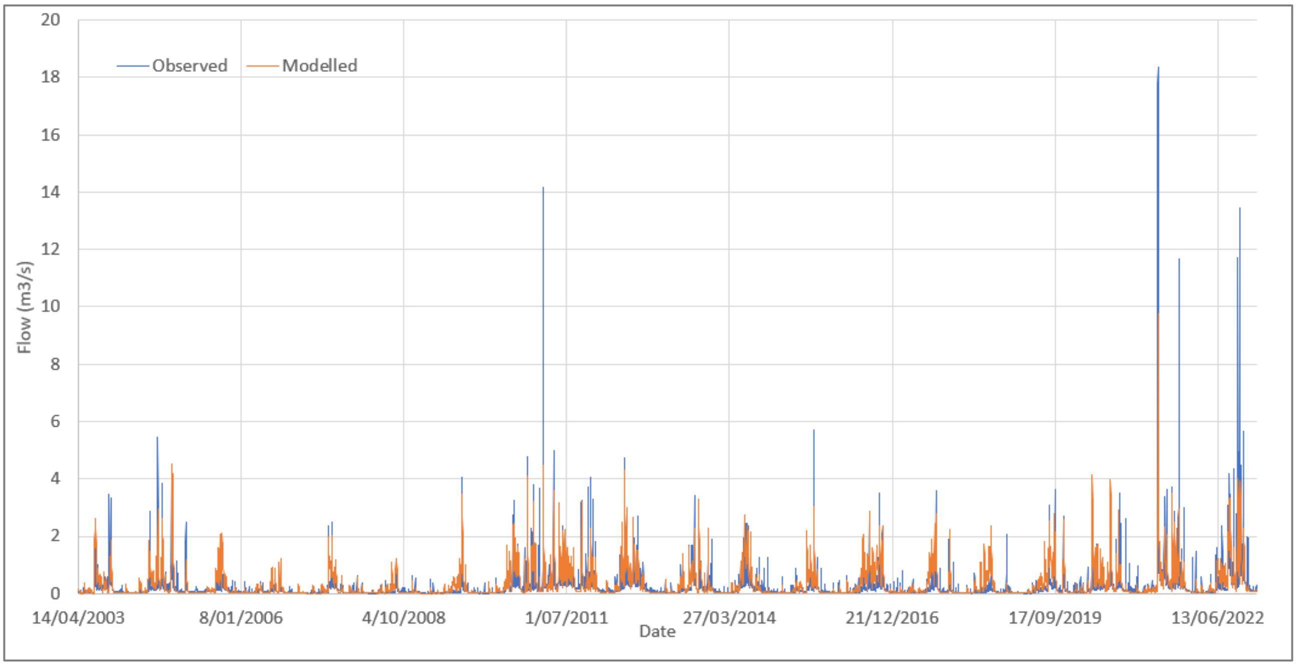

Figure 6-11 AWBM Calibration - Daily modelled and observed flow for the Hoddles Creek catchment

6.4 Results

6.4.1 Natural Conditions

Figure 6-12 shows the modelled annual flow volumes of Moora Creek at the confluence with Ure Creek (Figure 6-2) under natural conditions (no quarry). The maximum simulated annual flow was 3,593 ML/year and the median was 1,654 ML/year. The minimum annual flow was 161 ML/year.

Figure 6-13 shows the daily flow duration curve which outlines the probability of exceeding a particular flow rate in Ure Creek (downstream of the Moora Creek confluence). This highlights the waterway is flowing for most of the year; however, may become ephemeral and stop flowing in periods of low rainfall. This aligns with anecdotal evidence provided during the investigation.

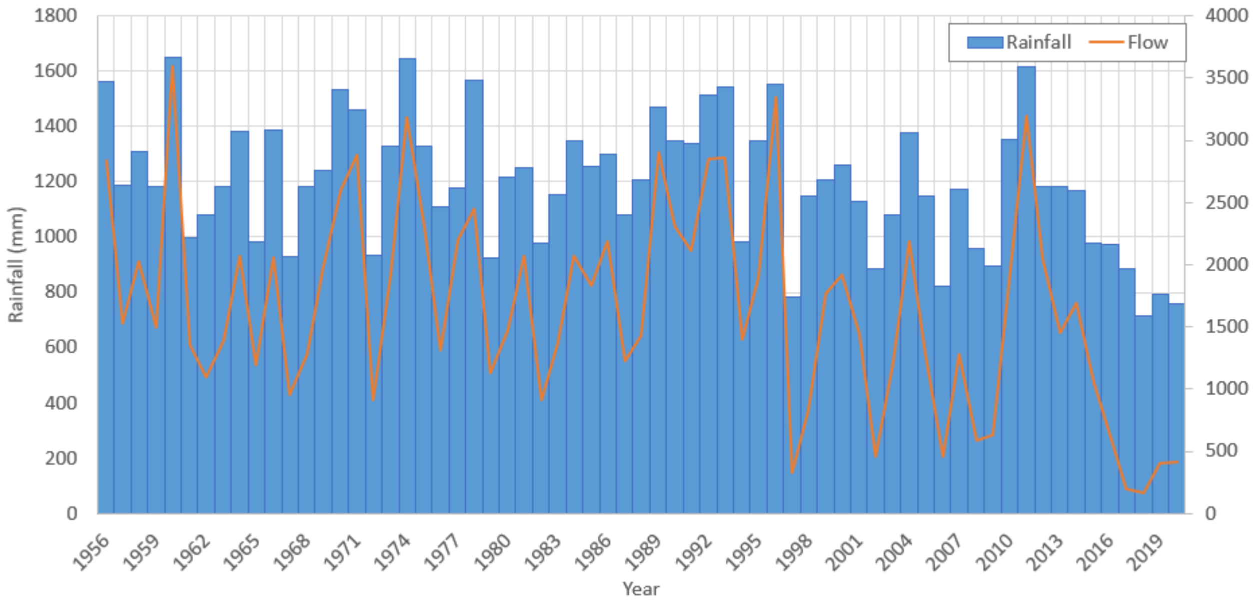

Figure 6-12 Rainfall and modelled flow volumes at the Moora Creek outlet to Ure Creek - natural conditions

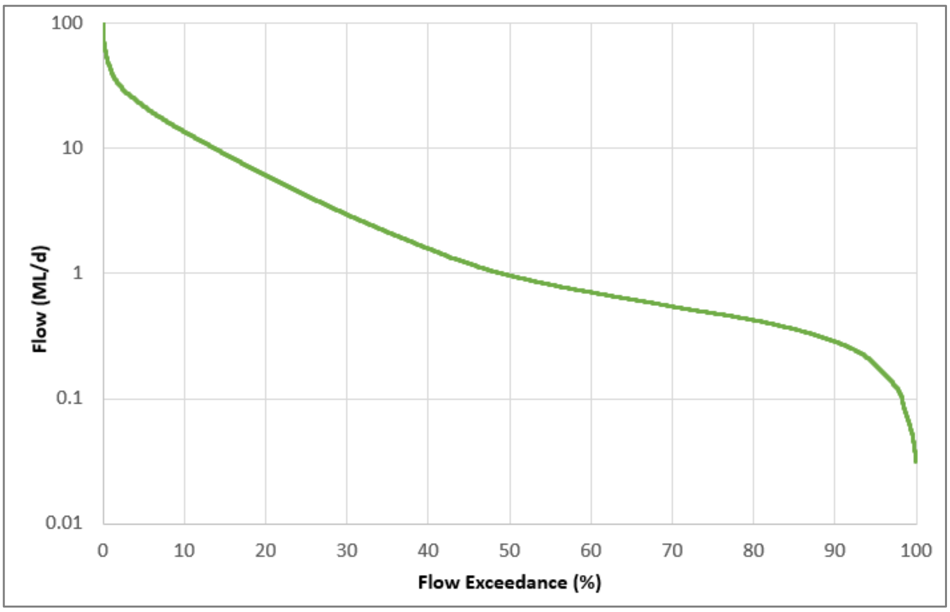

Figure 6-13 Daily flow exceedance curve at the Moora Creek outlet to Ure Creek - Natural conditions

6.4.2 Existing Conditions

Existing conditions Source modelling simulated the quarry under its current operation (2023) WA375 operating conditions with the use l of 10ML/Year through onsite dust suppression usage.

Figure 6-14 shows the modelled annual flow volumes at the model outlet (downstream of the Moora Creek confluence with Ure Creek) compared to the flow under natural conditions.

The median annual flow rate decreased to 2,605 ML/year from 2,650 ML/year, largely due to the change in catchment conditions, water usage and evaporation within the storages. Currently, the intercepted catchment area is 56.4 Ha., which represents 13 % of the Moora Creek catchment draining to Ure Creek at the Source model outlet, or around 7% of the total Ure Creek catchment area.

Despite the interception of Tributary 1 into the quarry and the operational use of 10 ML / year and evaporation losses due to the Main Dam and Holding Dam, excess water is released to the Ure Creek from the Holding Dam and Main Dam via a pipe and spillway. Figure 6-14 shows the modelled annual flow volumes in the current quarry operating conditions are similar to natural conditions (pre-quarrying).

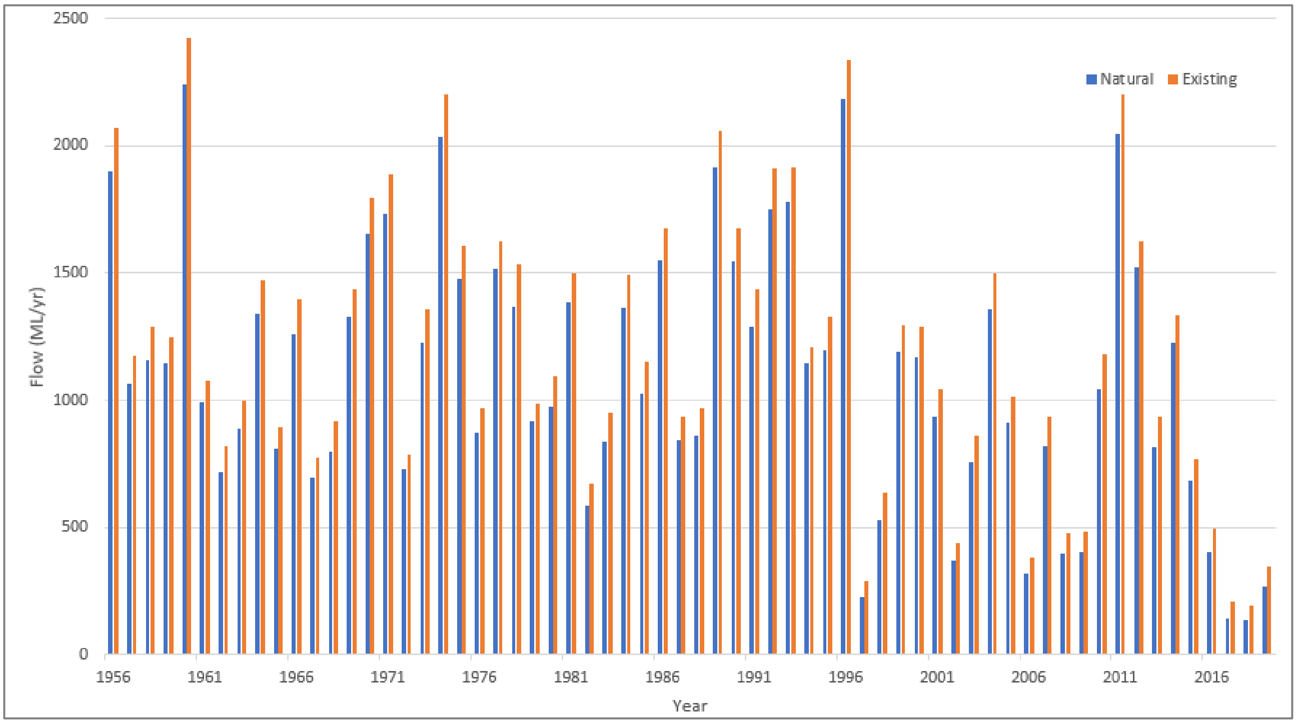

Figure 6-14 Modelled annual flow at the model outlet in existing conditions and natural conditions

When assessing the results within Moora Creek downstream of the quarry outlet, the median annual flow rate decreased slightly from 1,674 ML down to 1,628 ML, while the cease to flow threshold (based on a cease to flow rate of 0.1 ML/d) increased from 6.5 to 7.9 days/year.

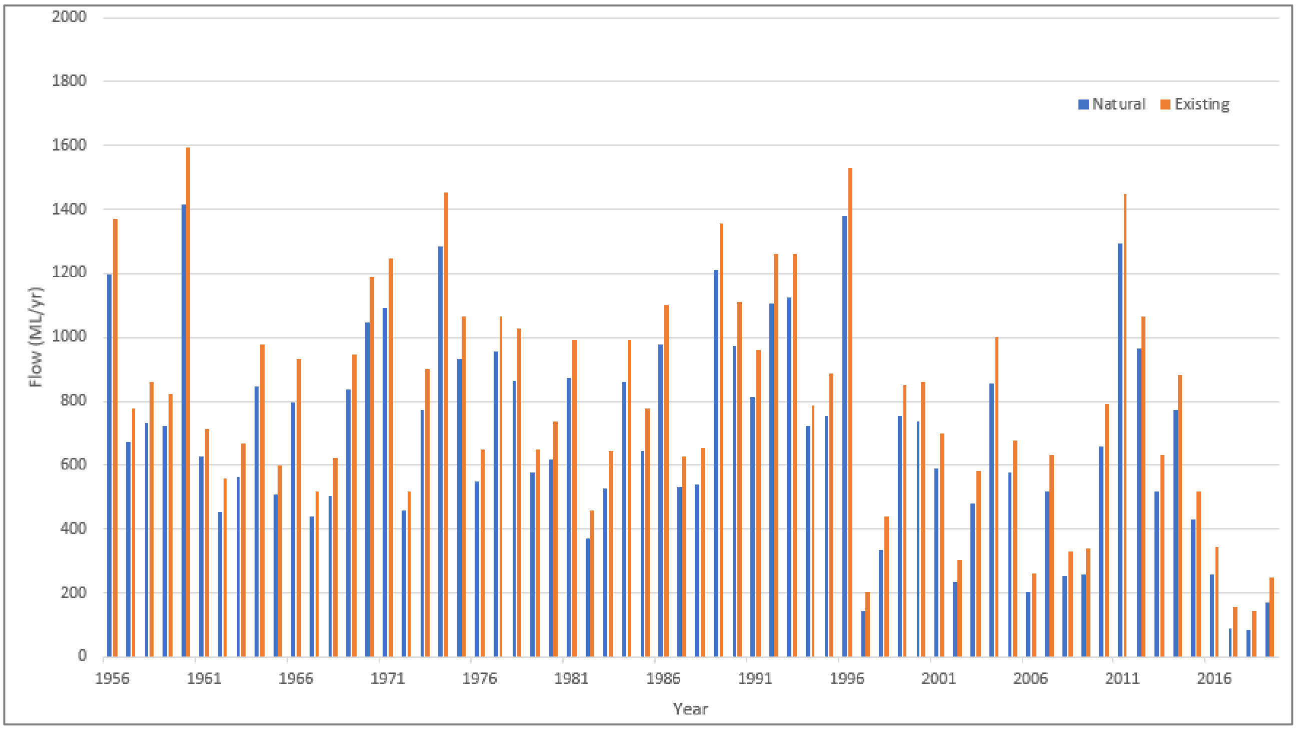

Figure 6-15 Modelled annual flow at the Moora Creek Outlet (to Ure Creek) in existing conditions and natural conditions

6.4.3 Proposed Expansion and Pit Development Stages

The proposed expansion to the quarry will intersect two additional tributaries of Ure Creek (Tributary 2 and Tributary 3 in Figure 6-2). The first stage of the quarry expansion intersects Tributary 2 followed by the second stage which intersects tributary number 3. Since the quarry pit is located at the lower end of the sub catchments, runoff generated upstream will flow into the quarry pit in a similar manner to existing conditions. Runoff into the pit will be pumped to a Holding Dam before being used for quarry operations as explained in the previous section. Overflow of the Holding Dam is expected to be released into Tributary 1 and thence Moora Creek in a similar location and manner to existing operating conditions. It is noted that the current Holding Dam is located in the proposed expansion pit location and will require relocation. The annual consumption of water used for operation on site is expected to increase from 10ML/year to an upper estimate of 20ML/year.

Consequently, there are expected to be changes in downstream flow regimes at the quarry outlet into Moora Creek for all quarry expansion scenarios. The results presented below aim to quantify the changes for key stages of the proposed quarry expansion that results in two distinct hydrological phases:

Phase 1 of the hydrological assessment considers Stage 1 of the Extraction Pit expansion which intercepts Tributary 2 (Figure 6-4).

Phase 2 of the hydrological assessment then incorporates Stages 2, 3 and 4 of the Extraction Pit expansion which intercepts both Tributary 2 and Tributary 3 (Figure 6-6).

Tables throughout the report reference these hydrological phases.

6.4.3.1 Phase 1 – Hydrological Assessment

The intersection of Tributary 2 captures 44 ha of upstream catchment, with 11 ha converted to “quarry area” type with the Source model. The removal of the Tributary 2 removes around 13% of the catchment area to Moora Creek for a reach of 250m from where Tributary 2 would typically flow to Moora Creek. This is due to Tributary 2 runoff now being routed through the quarry, pumped up to the Holding Dam and overflowing into Tributary 1 thence Moora Creek 250m downstream. The reach of Moora Creek impacted is highlighted in Figure 6-16.

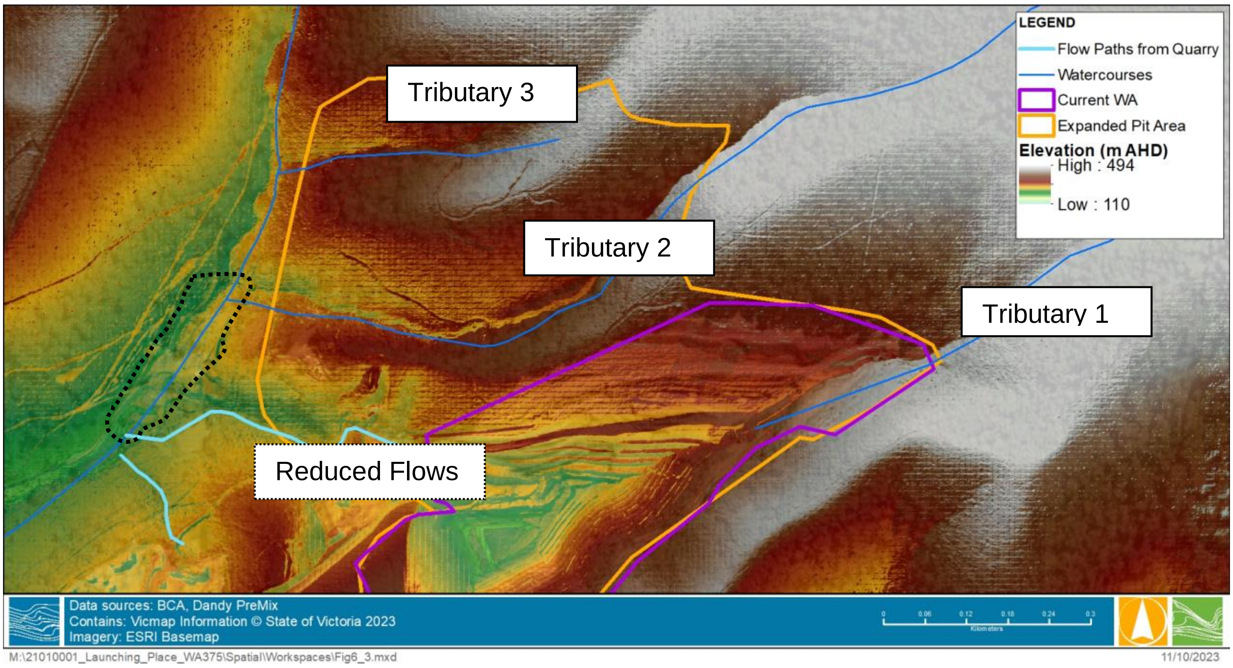

Figure 6-16 Moora Creek impacted as Tributary 2 intercepted

6.4.3.2 Phase 2 Hydrological Assessment

As the proposed Extraction Pit expansion progresses, the intersection of the quarry with Tributary 3 captures an additional 12 ha of catchment, combined with the 44 ha catchment removed in expansion stage 1 representing around 17% of the Moora Creek catchment to this point. 5 ha of the catchment will be converted to "quarry", along with 11 ha from expansion stage 1.

The removal of Tributary 3 from the catchment is expected to result in reduced flows in Moora Creek for around 450m from where Tributary 3 would naturally flow into Moora Creek at the quarry outfall. This is due to Tributary 2 & 3 runoff now being routed through the quarry, pumped to the Holding Dam and overflowing into Moora Creek (Figure 6-17).

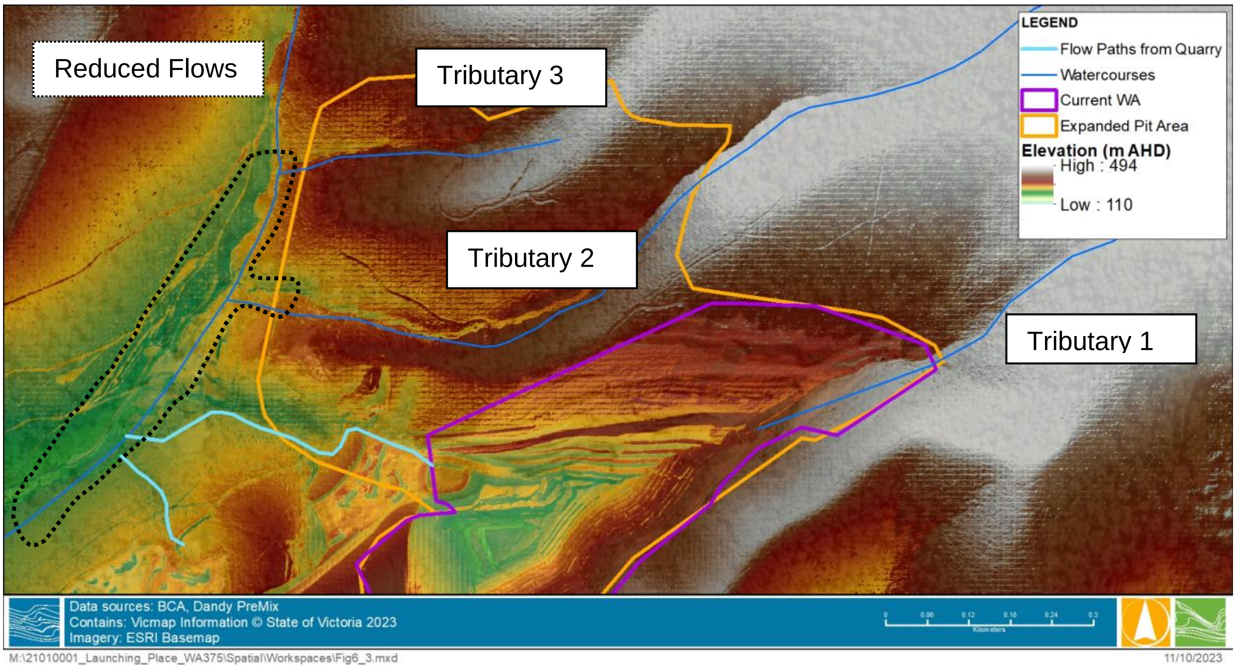

Figure 6-17 Moora Creek impacted as Tributary 3 intercepted

6.5 Result Summary

6.5.1 Moora Creek - Upstream of Quarry Inflow Results

A print location was provided at Moora Creek where Tributary 2 joins the waterway. This allows for an assessment of where the reduction in flow is likely to be most significant. An assessment of the annual flows (Table 6-2) at the confluence between Moora Creek and Tributary 2 shows the proposed expansion reduces annual flow rates between 10-15%. There is an increase in the number of times the “cease to flow” threshold of less than 0.1ML/d from around 10.2 days up to 12.6 days (Phase 1 expansion) and 15 days (phase 2 expansion).

The daily flow statistics (Table 6-3) highlight the reduction in flows expected at this location for both stages of the expansion. The flow duration curve (Figure 6-18) shows the general reduction in flow rates in both the expansion stages however the typical hydrological regime is relatively similar compared to existing conditions.

Table 6-2 Annual Flow Statistics – Moora Creek at Tributary 2 Outlet

Annual Flow Statistic (ML/year)	Existing Conditions	Expansion – Phase 1		Expansion – Phase 2	
	Flow (ML/year)	Flow (ML/year)	Change from Existing Conditions (%)	Flow (ML/year)	Change from Existing Conditions (%)
Maximum	2567.6	2305.1	-10.2	2203.6	-14.2
Minimum	115.7	103.9	-10.2	99.2	-14.2
Mean	1182.1	1061.3	-10.2	1014.62	-14.2
Median	1069.7	960.3	-10.2	917.4	-14.2
Cease to Flow (< 0.1 ML/day)	10.2	12.6	+23.5	15.0	+47.1

Table 6-3 Daily Flow Analysis - Moora Creek at Tributary 2 Outlet

Daily Flow Statistic	Existing Conditions	Expansion – Phase 1	Change from Existing Conditions (%)	Expansion – Phase 2	Change from Existing Conditions (%)
Max (ML/day)	90.62	81.36	-10.22	93.09	+2.73
Min (ML/day)	0.02	0.02	0	0.02	0
Mean (ML/day)	3.25	2.92	-10.15	2.79	-14.15
Median (ML/day)	0.78	0.70	-10.25	0.59	-24.36

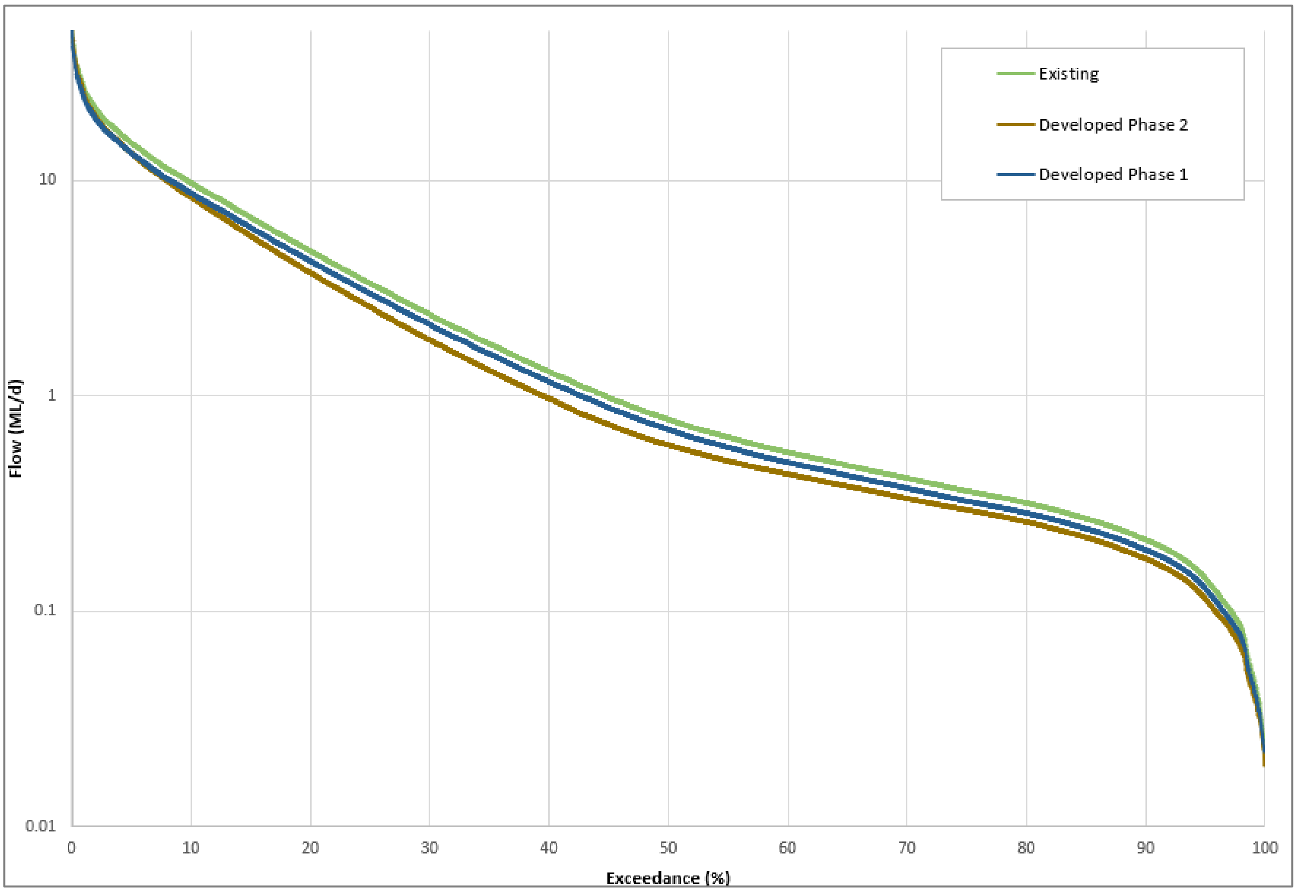

Figure 6-18 Flow Duration Curve – Moora Creek at Tributary 2 Outfall

6.5.2 Moora Creek Downstream of Quarry Outlet

Analysis of the modelled Moora Creek annual (Table 6-4) and daily flow (Table 6-5) statistics are provided below. The discharge volumes represent the amount of water passing along Moora Creek downstream of where the quarry releases enter back into Moora Creek. The average annual volumes and statistics all increase, however they do not vary significantly as a result of the proposed expansion as the runoff from the Tributary 2 and Tributary 3 catchments is diverted through the quarry before outflow into Moora Creek. There is an increase in the median and mean daily flow statistics, highlighting catchment conditions being impacted by the interception of the flows. There is a minor increase in the 'cease to flow' threshold exceedance on an annual basis.

Table 6-4 Annual Flow Statistics - Moora Creek Downstream of Quarry Outlet

Annual Flow Statistic (ML/year)	Existing Condition	Expansion – Phase 1		Expansion – Phase 2	
	Flow (ML/year)	Flow (ML/year)	Change from Existing Conditions %	Flow (ML/year)	Change from Existing Conditions %
Maximum	3376.2	3515.5	4.1	3436.7	1.6
Minimum	167.5	190.7	13.8	194.3	15.9
Mean	1610.2	1686.6	4.7	1671.6	3.8
Median	1477.6	1549.9	4.8	1538.0	4.1
Cease to Flow (< 0.1 ML/day)	7.5	9.1	20.1	10.8	43.0

Table 6-5 Daily Flow Analysis - Moora Creek Downstream of Quarry Outlet

Daily Flow Statistic	Existing Conditions	Expansion – stage 1	Change from Existing Conditions (%)	Expansion – stage 2	Change from Existing Conditions (%)
Max (ML/day)	105.9	97.5	-7.93	111.4	+5.19
Min (ML/day)	0.03	0.03	0	0.02	-33.3
Mean (ML/day)	4.4	4.65	+5.68	4.6	+4.55
Median (ML/day)	1.3	1.3	0	1.2	-7.69

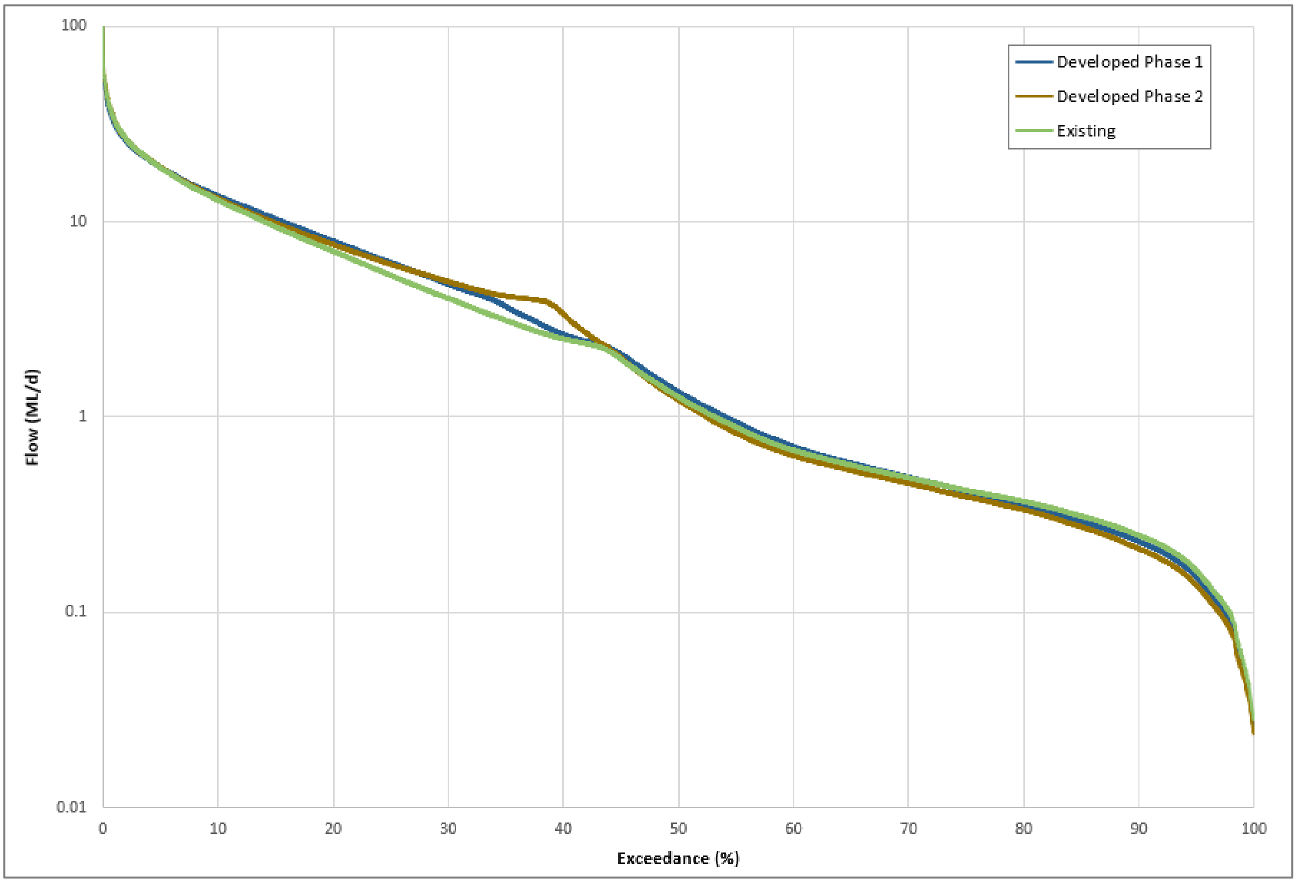

Figure 6-19 Daily flow exceedance curve, Moora Creek downstream of quarry outlet

6.5.3 Quarry Outlet

A summary of the annual flows leaving the quarry site is provided in Table 6-6. This shows the volume of flow being diverted into the site, through the storages and leaves the quarry increases significantly. On average, the volume of water being released from the expanded WA375 site will almost double with the interception of Tributary 2 and will more than double with the interception of Tributary 3 when compared with existing conditions.

Table 6-6 Annual discharge statistics from the quarry

Annual Flow Statistic	Existing Condition	Expansion – Phases 1		Expansion – Phases 2	
	Flow (ML/year)	**Flow** (ML/year)	Change from Existing Conditions **(%)**	**Flow** (ML/year)	**Change from Existing Conditions (%)**
Maximum	485.5	873.2	79.9	929.5	91.4
Minimum	34.9	70.9	103.6	79.3	127.6
Mean	254.4	463.1	82.0	496.4	95.1
Median	250.7	444.0	77.1	475.4	89.6

6.5.4 Model Outlet – Ure Creek

Table 6-7 provides a statistical analysis of the annual flow downstream of the Moora Creek confluence with Ure Creek (Figure 6-2) for each of the quarry scenarios modelled. The volume reduction compared to the natural conditions at this location is also noted in the daily flow statistics (Table 6-8). Table 6-7 shows the average and median flow at this location increases from existing conditions but is similar in all scenarios. The annual volume in Ure Creek (downstream of Moora Creek) does not vary significantly for each of the scenarios. However, the volume of water intercepted and flowing through the quarry will be higher in both of the hydrological phases. The 'cease to flow' threshold does increase on average an additional one day per year (compared to existing conditions).

Figure 6-20 shows there is some variance in flow duration curves in the expansion scenarios when flow rates are between 5-10 ML/d due to the interception of the Tributary 2 and Tributary 3. Outside of these flow rates, flow duration behaviour is generally consistent for each scenario.

Table 6-7 Annual Flow Statistics - Catchment Outlet

Annual Flow Statistic	Natural Flow	Existing Conditions	Expansion Phase 1	Expansion pHase 2
Maximum (ML/year)	5688.9	5472.7	5612.1 (+2.5%)	5533.2 (+1.0%)
Minimum (ML/year)	256.3	262.0	285.1 (+8.8%)	290.7 (+11.0%)
Mean (ML/year)	2650.1	2605.5	2682.5 (+3.0%)	2688.7 (+3.2%)
Median (ML/year)	2397.3	2375.1	2447.1 (+3.0%)	2457.3 (+3.5%)
Cease to Flow (< 0.1 ML/day)	2.8	3.4	3.8	4.3

Table 6-8 Daily Flow Analysis - Model Outlet

Daily Flow Statistic	Natural Conditions	Existing Conditions	Expansion – Phase 1	Expansion – Phase 2
Max (ML/day)	240.3	179.9	171.5	200.1
Min (ML/day)	0.05	0.05	0.05	0.04
Mean (ML/day)	7.2	7.1	7.3	7.3
Median (ML/day)	1.5	2.1	2.1	1.9

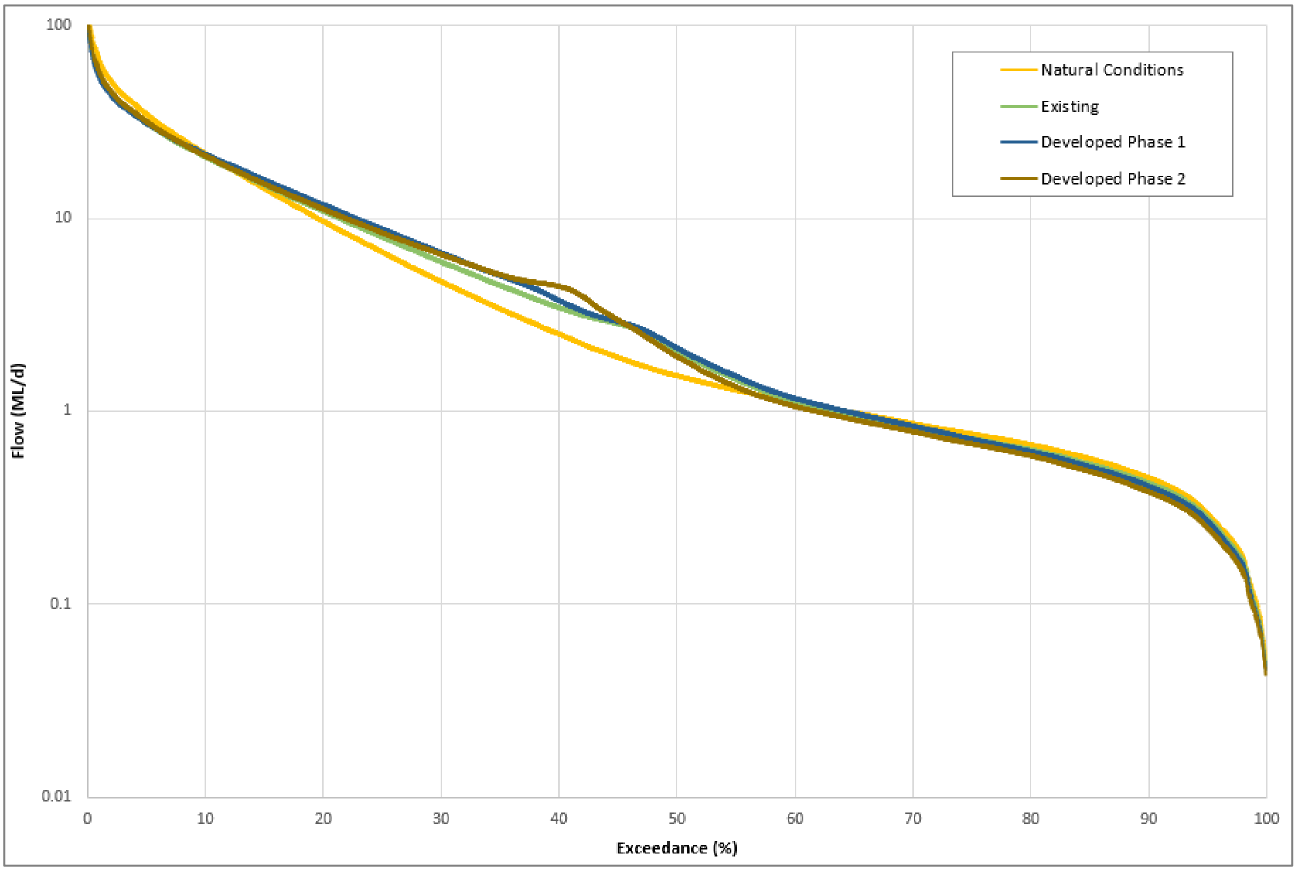

Figure 6-20 Flow Duration Curve – Model Outlet (Ure Creek)

6.5.5 Final Pit Void Calculation

Water balance modelling of this scenario removes the extraction of water from the quarry pit, for which the holding and Main Dams had a 20ML/year for annual use. The Source model utilised daily rainfall and evaporation data and generated runoff on a daily basis from the upstream catchment and also from the Extraction Pit itself. The Extraction Pit area sub-catchment (that isn't water body – i.e. pit benches and walls is modelled as a 'quarry type' sub-catchment). As water levels in the Extraction Pit and lake area increase, the (quarry type) sub-catchment area decreases.

The water balance model shows the pit will take around 13.1 years to reach the spill level of 217m AHD as shown in Figure 6-21 based on a water balance model period using historical rainfall data starting from 1955. Given this 13-year period, is representative of above average rainfall (1955-2023), a sensitivity analysis based on an 'dry period' (beginning January 1, 2000) was also undertaken. During this period beginning 1 January 2000, the Extraction Pit Lake takes 16.5 years to fill, an additional ~3.4 years compared to the base case. Similarly, a 'wet period' scenario was undertaken based on rainfall data starting on January 1, 1984 to represent the wettest period of rainfall records. In the 'wet period', the pit fills in 11.7 years, around ~1.4 year faster than the base case conditions.

Once the pit is filled, flows out of the pit will be driven predominately by runoff from the upstream catchment followed then by groundwater net flow and direct rainfall/evaporation within the pit. Following the filling of the pit, the level is modelled to stay at or close to spill level.

The impact of groundwater was not assessed as part of the water balance model in this investigation. However, JLCS modelling suggests the inclusion of groundwater inflow would result in shorter filling times in the order of 2-5 years (assuming constant groundwater inflow rate).

Further details on the hydrogeology component were undertaken by John Leonard Consulting Services. Analysis of the estimated pit inflow from John Leonard Conducting Services highlights the difficultly in determining hydraulic conductivity (and subsequently) pit inflows in fractured rock aquifers. Calculations provided by JLCS[2] range from 54.75 -1277.5ML of groundwater may infiltrate the pit annually.

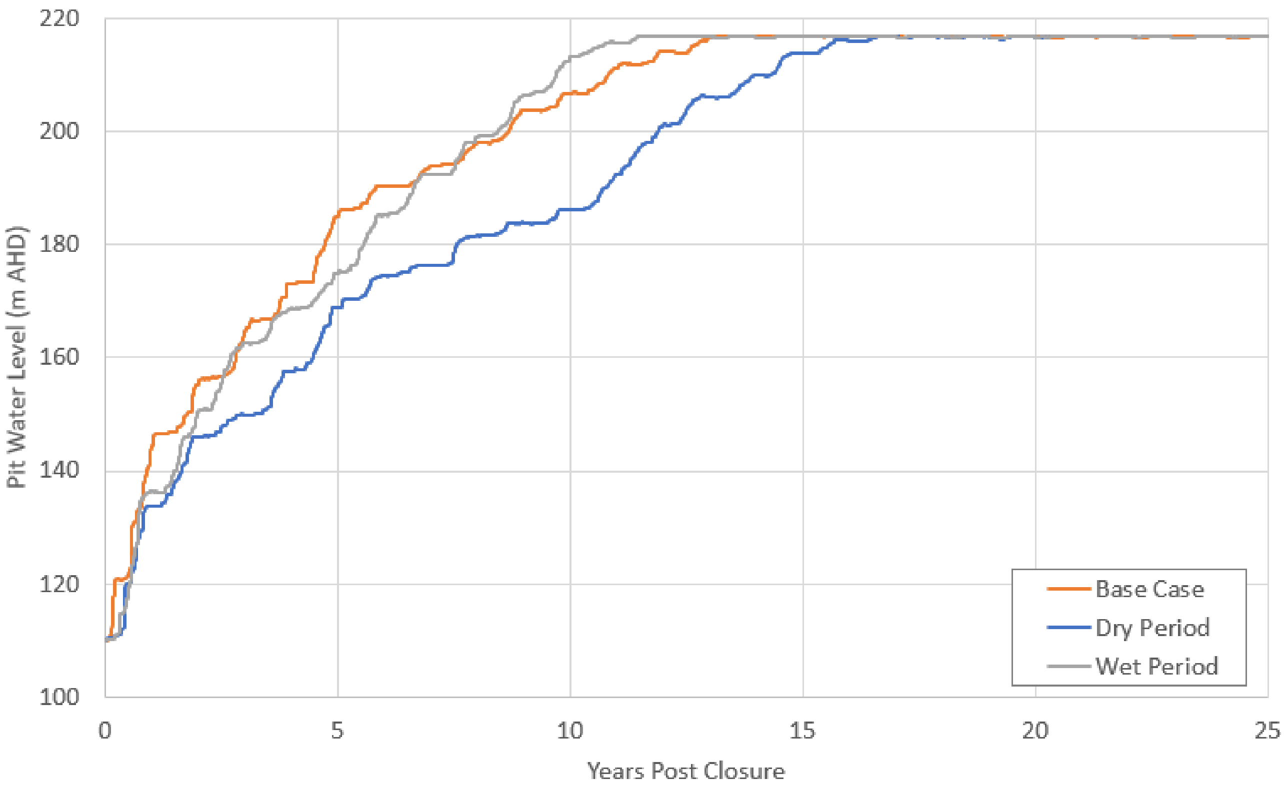

Figure 6-21 Water Level of the pit following quarry closure (surface water flows only)

In the initial period following the end of quarrying operations, no flows leave the quarry as the Extraction Pit Lake fills to the spill level (217m AHD). Based on modelling, this is expected to be in the order of 11.6-16.5 years. A summary of the annual flows leaving the quarry site is provided in Table 6-9 for the period once the pit has been filled. This shows on average, the volume of water being released from the site increases. This is due to the interception of Tributary 2 and Tributary 3 as well as a higher proportion of rainfall from the catchment being converted to runoff once the pit. Based on the modelling, there would have been 5 years where there was no outflow from the pit lake (during periods of low rainfall). Table 6-10 shows the average annual changes to Moora Creek downstream of the quarry once the pit has filled. This shows an average increase in flow volumes of around 6%. Further down the catchment (downstream of the confluence with Ure Creek, the average flow volumes increase is reduced to less than 4%.

Table 6-9 Annual discharge statistics Quarry outlet – Post Pit Filling

Annual Flow Statistic	Existing Condition	Post Equilibrium	
	Flow (ML/year)	**Flow** (ML/year)	**Change from Existing Conditions**
Maximum	485.5	1081.7	122.8%
Minimum	34.9	52.7	51.0%
Mean	252.9	552.9	118.6%
Median	256.5	563.5	122.4%

Table 6-10 Annual discharge statistics Moora Creek downstream of the quarry – Post Pit Filling

Annual Flow Statistic	Existing Condition	Post Equilibrium	
	Flow (ML/year)	**Flow** (ML/year)	**Change from Existing Conditions**
Maximum	3227.0	3417.9	5.9%
Minimum	167.5	165.7	-1.1%
Mean	1583.7	1683.0	6.3%
Median	1547.0	1641.2	6.1%

Table 6-11 Annual discharge statistics Ure Creek (Model Outlet) – Post Pit Filling

Annual Flow Statistic	Existing Condition	Post Equilibrium	
	Flow (ML/year)	**Flow** (ML/year)	**Change from Existing Conditions**
Maximum	5178.9	5369.4	3.7%
Minimum	262.0	260.2	>-1%
Mean	2533.4	2632.7	3.9%
Median	2469.1	2563.3	3.8%

6.5.6 Sensitivity Analysis

An additional sensitivity analysis to assess the length of time the Extraction Pit Lake will take to fill to spill level (217m AHD) was undertaken using Source. This involved the land use type of the Extraction Pit area being changed from "quarry type" to "forested type" land use. This is a conservative estimate assuming rehabilitation and revegetation returns the quarried areas to "forested type" conditions post quarrying activities. This extends the period from 13.1 years out to 20 years until the Extraction Pit Lake is filled.

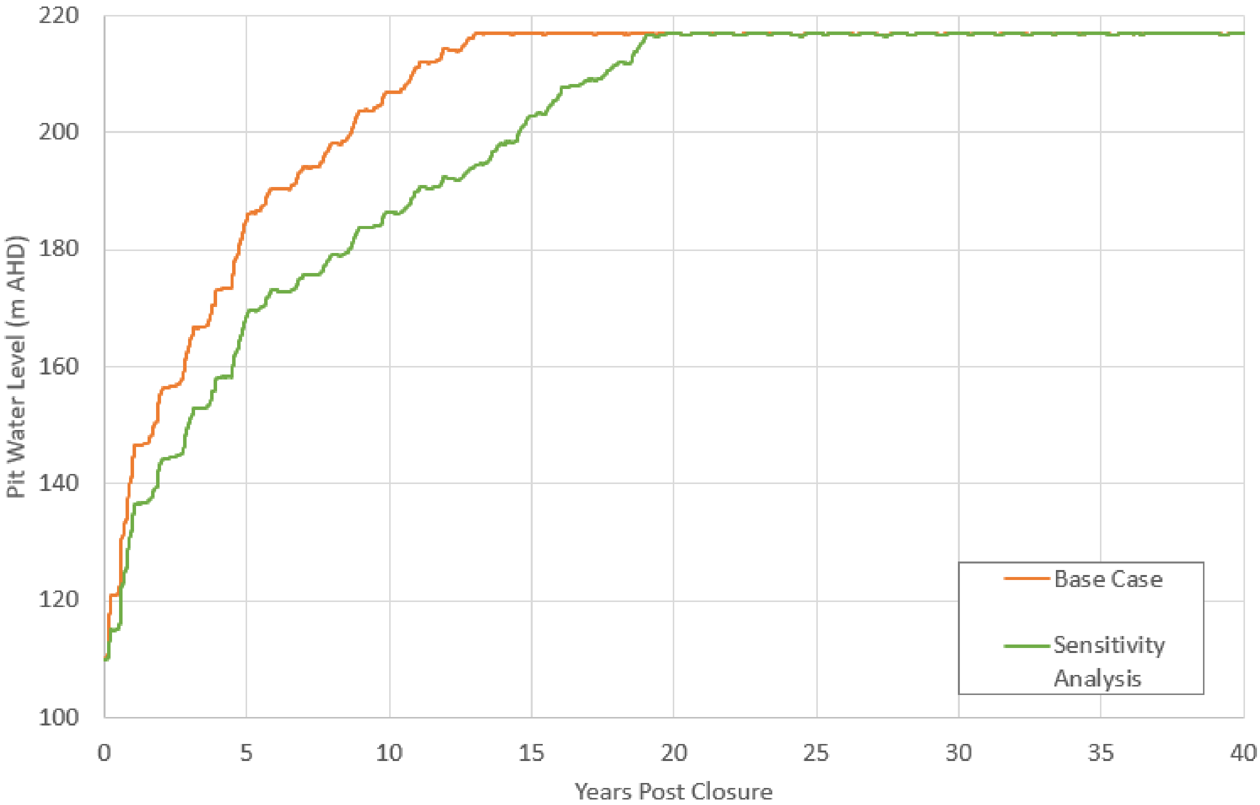

Figure 6-22 Water Level of the pit following quarry closure and sensitivity analysis of revegetation of quarry type catchment

6.5.7 Inclusion of Overburden

Overburden is defined as extremely and highly weathered Hornfels and clay materials extracted ahead of or in conjunction with the more highly valued Fresh Hornfels. Time to fill calculations have assumed a conservative volume approach, (with the volume of the pit Approx. 8,100,000m^3) does not consider any overburden from quarrying activities being placed within the pit void below the defined spill level of 217m AHD, based on the final pit design surfaces provided by BCA Consulting. Currently, the overburden volume estimate across the life of the expanded Extraction Pit is in the order of 3,700,000m^3. Based on anticipated overburden sales of 50% (1,850,000m^3), it is expected the remaining (excess) volume could be placed in the expanded pit void below the spill level of 217m AHD. This would reduce the final pit volume by around 22%, or 1,700,000m^3 to approximately 6,400,000m^3 with a consequent reduction in the time forecast for the pit to fill with water.

This scenario was not modelled as part of the water balance assessment as it is unknown if, or where overburden excess and planned site rehabilitation works would be located within the final Extraction Pit void. Any overburden placed within the Extraction Pit will decrease the Pit Lake volume and therefore reduce the expected filling period and period of impact on the downstream receiving waterways.

7 WATER QUALITY

7.1 Surface water contaminants

Water quality associated with the site was compared against the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG 2018), developed as part of the National Water Quality Management Strategy (NWQMS) (Australian Government 2018).

ANZG also recommend that site-specific guidelines for stressors be assessed wherever possible to establish a baseline condition.

7.2 Water Quality Monitoring

As outlined in Section 4.6, there is existing water quality data for both groundwater and surface water around the site. The monitored site locations are presented in Section 3.7.

7.2.1 Existing Data

As part of this report, a comparison of surface water upstream, throughout the Works Authority Area (currently used dams) and in the receiving waterway downstream of the site was undertaken. Salinity was assessed using Total Dissolved Solids (TDS) as the indicator for identifying Environmental Values. John Leonard Consulting Services identified the following findings from the three samples collected in 2022[2].

- *The salinity of the water collected from the two stream sampling locations, SW5 (*Moora Creek*) and SW6 (Ure Creek) were mostly less than 100 mg/L TDS except for the December 2022 sample from SW6 which was 230 mg/L TDS.*
- *The water samples from within the 2022 pit footprint (SW1, Extraction Pit sump; SW2, Holding dam; and SW3, Main Dam) were between 480 and 880 mg/L TDS except for the salinity high of 1,200 mg/L TDS in the June sample from SW3. The range in salinity reflects the relative contributions from surface water (predominantly) and groundwater (minor) input sources and evapo-concentration effects from the larger standing water bodies.*

7.3 Ongoing Monitoring

As per Craigie 2009[1], the development of an ongoing water quality monitoring program is likely to be required to ensure surface water captured in the pit and discharged into Ure Creek is suitable for release. It is recommended that a suitable water quality management plan be incorporated, with a suitable water quality monitoring program. A suitable water quality monitoring plan as per the ANZG (2018) guidelines would enable the establishment of baseline site-specific trigger values which could be invaluable to all future operations on site.

As part of establishing a baseline for water quality coming into the pit, it is understood Yarra Valley Quarries have engaged Eurofins to undertake sampling upstream of the quarry pit (along Tributary 1 drainage line). This is to provide a baseline of water quality for the tributary (cut by quarry extraction operations), before water/drainage runs down the upper quarry benches, i.e. before it has an opportunity to be polluted/contaminated by exposed clay overburden, or semi-weathered rock.

8 SURFACE WATER IMPACTS

The proposed expansion of the WA375 pit area leads to the interception of two ephemeral tributaries/gully lines draining to Moora Creek and thence Ure Creek. Water balance modelling has shown that the conversion of naturally vegetated land conditions to that of a quarry, results in a higher proportion of runoff in the 'quarry' areas compared with existing conditions. This is inline with previous reports and literature [3].

The expansion of the quarrying operation into the proposed Lot50C extraction area and the rehabilitation and revegetation of the current extraction area once operations have ceased (part of WA375) is likely to impact on the receiving waterways.

In response to the objectives outlined earlier in Section 2.2, the following impacts in relation to the surface water assessment have been noted.

8.1 Flooding Impacts

The water balance modelling shows there is an overall change in flow to the receiving waterway. While the change to the catchment through the conversion of "forested" area to the quarry Extraction pit, the interception of catchment flows into the Extraction Pit results in no increase in peak flow rates throughout the forecast operational lifecycle of the quarry. This is largely due to the Extraction Pit acting as a de facto retarding basin, with releases controlled by the pumping rate from the Extraction Pit sump to the Holding Dam and thence to Moora Creek.

From an event based perspective, the changes to the hydrological regime and interception of the tributaries and upstream catchment and diversion of flows into the Extraction Pit do not result in increased peak flows in the downstream receiving waterway. Flood modelling was not required to assess this as any pumping rate from the Extraction Pit is expected to be far lower than the pre-development flow rate of the intercepted catchment area.

Once rehabilitation has been achieved and the Extraction Pit lake has filled and stabilised, there is a risk that flows in the downstream receiving waterway (Moora Creek) could be slightly increased in the event of a heavy and sustained rainfall event. This would be due to the increased runoff from the Extraction Pit lake if the lake is full at the start of the rainfall event. The potential increases risk is considered to be relatively minor.

To ensure release from the pit does not exceed current conditions, a spillway will be sized during detailed design to ensure convey flows in the 1% AEP event do not exceed the current flow rate in Moora Creek downstream of the site.

8.2 Waterway Impacts

8.2.1 Quarrying Operation

The water balance modelling shows annual flows (Table 6-2) at the confluence between Moora Creek and Tributary 2 shows the proposed expansion reduces annual flow volumes. Annually, minimum flow volumes show the greatest change, close to a 50% reduction in the lowest flow while the mean, median and maximum reduce by around 18-25%. Daily flow statistics (Table 6-3) highlight a significant increase in the number of times the "cease to flow" threshold of 0.1ML/d is exceeded within this reach.

[3] Langford, Moran and O'Shaughnessy, (1982), The Coranderrk Experiment - The effects of roading and timber harvesting in a mature mountain ash forest on streamflow yield and quality. prepared for MMBW.

Downstream of where the quarry outflows re-enter Moora Creek, average annual volumes do not vary significantly. There is a reduction in the minimum annual flow rate which along with the daily flow statistics highlights Moora Creek will be impacted by the interception of the flows with the 'cease to flow' threshold exceedance increased significantly.

Further downstream where Moora Creek enters Ure Creek, the impacts of the Extraction Pit interception of Tributary 2 and Tributary 3 are less due to the addition of Ure Creek catchment flows.

An assessment of waterway cross sections of Ure Creek, extracted at downstream of the tributary outflows into the Ure Creek, was undertaken using a Manning's Equation. Water levels and typical flow behaviour were calculated at two locations for both existing and developed conditions to identify the impact that reduced flows may have on the existing habitats within the riparian zone for several flow components.

The modelled reductions in average flow rates and water levels were determined as potentially having a relatively minor impact on flow components (i.e. pulses, flushes and bankfull/out of bank flows). However, it is recommended that an ecological impact assessment on the 450m reach of Moora Creek upstream of where the quarry flows are released into Moora Creek and downstream of the Moora Creek connection to Ure Creek be undertaken to ascertain if there are vulnerable flora and fauna habitats that may be impacted as a result of reduced flows especially during the Extraction Pit Lake fill period.

8.2.2 Hydrological Regime Post Operation (Rehabilitation and Revegetation)

Following completion of quarrying activities and the removal of controlled releases from the Holding Dam, there is a period of around 13.1 years before flows from the Extraction Pit are reinstated (once the pit Lake has filled). This period is likely to have the largest impact on the receiving waterway (Moora Creek) through a reduction in flows. The 450m reach of the Moora Creek waterway upstream of where the quarry flows are released into Moora Creek will have the greatest impact from the reduction in flows it would naturally receive from Tributary 2 and 3. Annual flow statistics for this location are shown in Table 8-1 based on a base case scenario. Flow statistics for Moora Creek downstream of the Quarry Outlet (Table 8-2) and also for Ure Creek downstream of the Moora Creek confluence (Table 8-3) are also shown below. The results show a reduction in flow volumes (as expected across the initial filling period).

Once the Extraction Pit Lake fills and flows from the quarry are reinstated to Moora Creek, water balance modelling shows the flow regime impact will be limited to a 250m reach of Moora Creek upstream of where the quarry flows are released as highlighted in Section 6.5.5.

Table 8-1 Annual discharge statistics Moora Creek upstream of the quarry – Post Operation

Annual Flow Statistic	Existing Condition	Prior to the Pit Filling	
	Flow (ML/year)	**Flow** (ML/year)	**Change from Existing Conditions**
Maximum	2567.6	2200.1	-14.31%
Minimum	64.4	59.5	-7.6%
Mean	1173.0	1005.5	-14.3%
Median	1032.3	884.2	-14.4%

Table 8-2 Annual discharge statistics Moora Creek downstream of the quarry – Post Operation

Annual Flow Statistic	Existing Condition	Prior to the Pit Filling	
	Flow (ML/year)	**Flow** (ML/year)	**Change from Existing**

			Conditions
Maximum	3376.2	2509.7	-25.6%
Minimum	87.5	67.8	-22.5%
Mean	1599.9	1150.2	-28.1%
Median	1449.6	1008.7	-30.4%

Table 8-3 Annual discharge statistics Model Outlet Ure Creek – Post Operation

Annual Flow Statistic	Existing Condition	Prior to the Pit Filling	
	Flow (ML/year)	**Flow** (ML/year)	Change from Existing Conditions
Maximum	5472.7	4506.2	-15.8%
Minimum	140.1	124.5	-11.1%
Mean	2258.7	2108.4	-17.6%
Median	2283.4	1851.2	-18.9%

8.2.3 Water Quality

The 2009 Drainage and Water Quality Management document developed by Neil Craigie identified a water quality treatment solution to ensure best practice objectives are met.

Under the proposed expansion, the flow rates and volumes that the current treatment solution (Extraction Pit sump and Holding Dam referenced in Craige 2009) are treating, are to increase in magnitude. Further water quality investigation to identify if the current water quality treatment is sufficient and the expected impact of the increased volumes to be treated will be required at detailed design stage. From here, modelling can be undertaken to determine the need for further treatment and establish a sedimentation clean out frequency throughout each stage of the quarry expansion.

8.3 Management Recommendations

Under current conditions, higher seasonal inflows that exceed the fill capacity of the Holding Dam are discharged via 300 mm pipe and spillway to Moora Creek. Any surplus surface water captured in the 'Main Dam' is to discharge via a spillway. Currently surface water runoff from the quarry entrance/weighbridge area is discharged from the site into Ure Creek at McMahons Road via the existing concrete lined drain on the east verge of the main access road and part of McMahons Road. It is understood there is a sediment trap located along this drainage line.

Under the proposed expansion, a similar water management plan is expected to satisfy the requirements set out in Section 2.2.

8.3.1 Holding Dam

Under the current operation, there is deposition of sediment in the Extraction Pit sump prior to pumping to the Holding Dam. Further deposition of fine sediment occurs in the Holding Dam prior to spilling via the 300mm diameter pipe and spillway to Tributary 1 thence Moora Creek.

As part of the detailed design (as part of a water management plan) for the proposed expansion, it is recommended that the Holding Dam or a separate sedimentation basin that can be cleaned out as part of a maintenance schedule be installed and a sedimentation clean out schedule should be developed.

A separate sedimentation basin could be placed prior to flows entering Tributary 1 and thence Moora Creek after leaving the Holding Dam.

The progressive relocation of the Holding Dam closer to the location where Tributary 1 & 2 enter Moora Creek would allow for a reduced area of impact on those reach of waterway where the flows from the spill level flows Holding Dam currently re-enter Moora Creek (Figure 6-16 and Figure 6-17).

8.3.2 Extraction Pit Lake Outlet

The water balance assessment undertaken as part of this report has been based on daily and annual flow rates. The peak flow rate in 1% AEP event under existing conditions should be determined. The sizing of the Extraction Pit Lake outlet structure to maintain this flow rate for developed conditions is not exceeded should be undertaken at a detailed design stage to ensure no increased flood risk.

8.3.3 Diversion of Tributary inflows

DEECA–Earth Resources Regulation require catchment flows to enter the extraction area (runoff entering the pit) is to not have concentrated flow over any overburden. To deal with the risk of long term stability issues with surface runoff from Tributary 1 as well as tributaries 2 and 3 entering the pit where overburden is likely to be placed, several options to mitigate this are discussed below.

As the pit expands and intersects Tributaries 2 and 3, the tributary pathways will be progressively aligned to allow flow down the final batter profile as shown in the stage plans of the BCA stage plans of the Site Layout Plan (Figure 8-1) provided by BCA.

The existing Tributary 1 will be temporarily realigned prior to the placement of overburden to run west along a suitable upper final bench (dependant on material encountered), then down the final batter profile offset from the edge of the planned placed overburden (Figure 8-1). Once the overburden placement is finalised, Tributary 1 will be relocated to run along the rehabilitated surface of the overburden. To minimise long-term stability and erosion risk, treatment work will be undertaken along the Tributary 1 pathway to prevent erosion through the use of erosion control measures including geofabric liner with sized stone or use of a rock chute, or a combination of both.

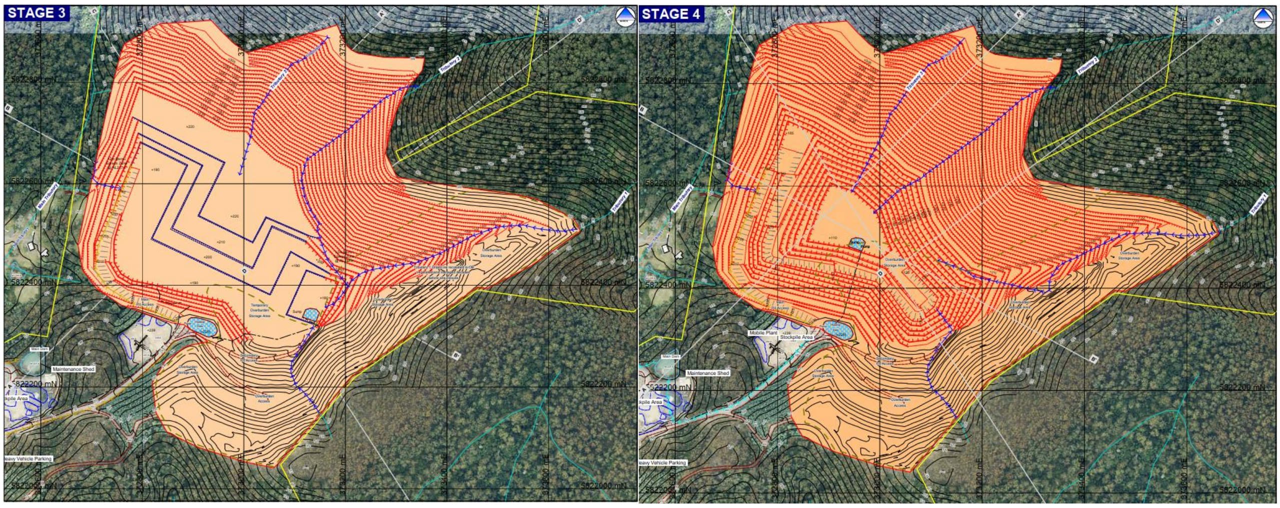

Figure 8-1 Stage 3 of expansion - Site Layout Plan (Source: BCA)

Alternatively, another option is to construct a diversion drain cut into the hard rock to convey a 1% AEP design flow rate from Tributary 1 west along a hard rock bench to the inflow location of Tributary 2 once it has been intercepted.

A small hydrological model was developed to ascertain peak flows for the upstream catchment assuming the concentration of flows into the northeast corner of the pit. A RORB model was developed and a peak design 1% AEP flow rate of 1.3m^3/s. This was checked against empirical estimates including the Regional Flood

Frequency Estimation Tool[4]. The peak flow rate was then used to size a cut off drain that could sufficiently convey the 1% AEP flow from the northeast of the pit to a location further west which would not flow over the overburden. The Manning's calculation (Figure 8-2) shows a flow of 1.5m^3/s (slightly higher than 1% AEP flow) can be conveyed within a channel 10m wide (top width) and ~6.5m (base width) at the base with a depth of 0.2m. Any additional depth above this would provide additional freeboard.

Output Parameters		
Top width	10	m
Bottom width	6.73	m
Depth	0.20	m
Cross sectional area	1.71	m^2
Batter length	1.65	m
Wetter perimeter	10.03	m
Manning's n	0.035	
Hydraulic radius R	0.17	m
Velocity	0.88	m/s
Froude Number	0.62	

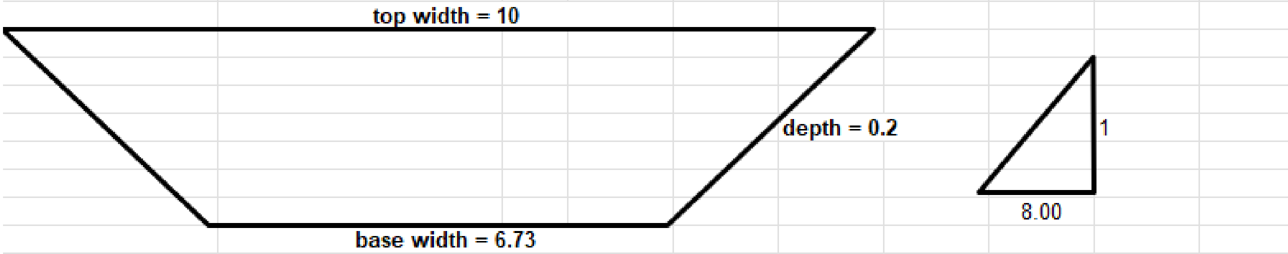

Figure 8-2 Diversion Channel Sizing

8.3.4 Water Quality Asset Maintenance Plan

Upon completion of baseline sampling, water quality modelling is required to appropriately size a sedimentation basin and identify a clean out frequency. This should be undertaken as part a maintenance program within the water management plan for the proposed SWQ treatment facilities is to be developed at a later stage once detailed design of the water and drainage assets is completed.

[4] Regional Flood Frequency Estimation Model. Release Version of the Regional Flood Frequency Estimation Model for the 4th edition of Australian Rainfall and Runoff. Method by Dr Ataur Rahman and Dr Khaled Haddad from Western Sydney University for the Australian Rainfall and Runoff Project.

9 SUMMARY

Dandy Premix Quarries Pty Ltd ('Dandy Premix') is seeking to expand their currently approved quarrying operations at the WA357 Launching Place site. The proposed expansion of the extraction area under the WPV, will result in the surface runoff flows from two drainage lines (ephemeral tributaries) being captured and redirected to the base of the expanded Extraction Pit. The two drainage lines of Ure Creek from within Lot 50C, drain a catchment of 56.4 Ha.

This report has been prepared as part of the technical assessment for the WPV application by Dandy Premix Quarries Pty Ltd (t/a Yarra Valley Quarries), for the proposed extension to the WA375 hard rock quarry at 130 McMahons Road, Launching Place.

Detailed water balance modelling has shown that:

- Under the current conditions, an average around 254 ML is discharged from the site into Moora Creek on an annual basis.
- Under the proposed expansion, this flow volume is expected to increase to around 463 ML/year once the first ephemeral/gully line (Tributary 2) is intercepted (in a 3-5 year time frame) and then up to around 496 ML/year as Tributary 3 is intercepted (in a 10-15 year time frame).
- To maintain water supply on site for operational usage, the volume of water storages on site is expected to increase.
- To accommodate the forecast water usage and expansion of the quarry pit, it is likely that the current storage facilities within the quarry will have to be increased. This would include:
  - Increasing the sump Extraction Pit sump size.
  - Increased pumping rate from the Extraction Pit sump to the Holding Dam.
  - Construction of a new Holding Dam or relocation of the existing Holding Dam to contain a larger volume of water.
  - Formalisation of sediment controls to allow for scheduled clean out frequency.
- Following the quarry expansion, flows within the 450m reach between the outfall of Tributary 2 and the current outflow location from the site will be reduced as the two tributaries (Tributary 2 and Tributary 3) are redirected to the quarry Extraction Pit sump.
- At the completion of quarrying, the Extraction Pit is assumed to be rehabilitated in a manner that will allow for the pit to fill over time predominately through surface water runoff, eventually reaching a spill level of 217m AHD. This is expected to occur in the order of 11-16 years post quarrying based on surface water inflow alone. The inclusion of groundwater into the calculations reduces the filling time in the order of 2-5 years.
- Any overburden placed within the Extraction Pit (which is not included in the water balance modeling) will decrease the Pit Lake volume and therefore reduce the expected filling period and period of impact on the downstream receiving waterways.
- Runoff from the Extraction Pit Lake once filled, would then overflow via a controlled outlet to Moora Creek and thence into Ure Creek.
- During the filling of the Extraction Pit Lake, without intervention, annual inflow volumes in Moora Creek and Ure Creek will reduce. The 450m reach between the outfall of Tributary 1 and the current Moora Creek inflow location of flows from the Holding Dam will have the largest proportion of flow reduction. Modelling results of these impacts are listed in Table 8-1 - Table 8-3

9.1 Response to Objectives

In response to the objectives outlined earlier in Section 2.2 we have provided the following summary:

- DEECA–Earth Resources Regulation guidelines regarding allowing upstream catchment flows to enter the extraction area, requires that the runoff entering the pit is to not have a concentrated flow over any overburden. A cutoff drain to capture the flows from Tributary 1 will therefore convey flows to an entry point elsewhere in the Extraction Pit.
- Stormwater runoff from any disturbed areas within the quarry will be captured and stored in a system similar to the current operation to ensure no polluted or sediment laden runoff discharges out of the work authority area unless approved under an EPA Licensed Discharge.
- A maintenance program for the current and proposed SWQ treatment facilities is to be developed at a later stage once detailed of assets is completed (water management plan).
- The water balance modelling suggests there is minimal change in daily and annual flow rates to Moora Creek and Ure Creek throughout the operational period of the quarry.
- As there should be no increase in flood risk to neighbouring properties or nearby public assets as a result of the proposed works, confirmation of the peak 1% AEP event in existing conditions and the sizing of an outlet structure to ensure this flow rate is not exceeded throughout the quarrying and post operation stages should be undertaken at detailed design stage.
- A water balance assessment of catchment yield shows there is a reduction in flows along a small reach of Moora Creek flowing adjacent to the site throughout quarry operation. The area of impact on Moora Creek is extended through to the outlet to Ure Creek once the quarry operations cease. During the rehabilitation and revegetation stage, a reach of Moora Creek downstream of the quarry through to Ure Creek will be impacted for around 10-13 years. This impact has been assessed through the water balance modelling and shown to have changes to the hydrological regime within Moora.

APPENDIX A
WATER QUALITY SAMPLING RESULTS

Extraction Pit SW1

Test	15/04/10	19/05/10	28/06/10	11/11/11	14/12/11	12/04/12	27/03/14	24/09/14	24/01/17	1/11/17	21/06/19	10/10/19	10/12/19	14/07/22	26/09/22	16/12/22
Ammonia (as N)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.15	0.33	0.61
Nitrate & Nitrite (as N)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.94	1.5	3.0
Nitrate (as N)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.94	1.5	3.0
Nitrite (as N) 0.02 mg/L < 0.02	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	<0.02	<0.02	<0.02
Organic Nitrogen (as N)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.27	1.59
Phosphate total (as P)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	<0.01	0.01	<0.01
Total Kjeldahl Nitrogen (as N)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	<0.2	0.6	2.2
Total Nitrogen (as N)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.94	2.1	5.2
TDS	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	480	880	610

Settling Dam SW2

Test	15/04/10	19/05/10	28/06/10	11/11/11	14/12/11	12/04/12	27/03/14	24/09/14	24/01/17	1/11/17	21/06/19	10/10/19	10/12/19	14/07/22	26/09/22	16/12/22
Ammonia (as N)	N/A	N/A	N/A			N/A			N/A	0.13	0.66	0.63	0.21	0.15	<0.01	0.58
Nitrate & Nitrite (as N)	N/A	N/A	N/A			N/A			N/A	1.9	2.9	3.5	4	0.94	0.14	2.8
Nitrate (as N)	2.1	2	1.8			0.98			8.6	1.9	2.9	3.4	4	0.94	0.13	2.8
Nitrite (as N) 0.02 mg/L < 0.02	0.012	<0.003	<0.003			<0.001			0.35	0.02	<0.02	0.03	<0.02	<0.02	<0.02	<0.2
Organic Nitrogen (as N)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.5	<0.2	<0.2	<0.2	N/A	0.4	1.72
Phosphate total (as P)	<0.004	0.009	0.009			0.03			0.006	<0.05	0.01	0.01	<0.01	<0.01	0.01	<0.01
Total Kjeldahl Nitrogen (as N)	0.74	0.54	0.2			0.18			4.3	0.6	0.8	0.7	<0.2	<0.2	0.4	2.3
Total Nitrogen (as N)	2.9	2.5	2			1.2			13	2.5	3.7	4.2	4	0.94	0.54	5.1
TDS	2	12	2			4			3	4.7	22	1.1	1.5	480	660	570

Main Dam SW3

Test	15/04/10	19/05/10	28/06/10	11/11/11	14/12/11	12/04/12	27/03/14	24/09/14	24/01/17	1/11/17	21/06/19	10/10/19	10/12/19	14/07/22	26/09/22	16/12/22
Ammonia (as N)	N/A	N/A	N/A		N/A	N/A	N/A	N/A	N/A	0.01	<0.01	0.03	0.01		0.21	<0.01
Nitrate & Nitrite (as N)	N/A	N/A	N/A		N/A	N/A	N/A	N/A	N/A	<0.05	0.22	0.32	0.19		1.2	0.90
Nitrate (as N)	0.33	0.11	0.42		0.44	0.15	<0.01	<0.01	<0.01	<0.02	0.21	0.32	0.19		1.2	0.90
Nitrite (as N) 0.02 mg/L < 0.02	<0.0003	<0.0003	<0.003		0.005	<0.001	<0.001	<0.001	<0.001	<0.02	<0.02	<0.02	<0.02		<0.02	<0.02
Organic Nitrogen (as N)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.4	<0.2	<0.2	<0.2		0.39	1
Phosphate total (as P)	0.012	0.013	0.014		0.022	<0.004	0.016	0.014	0.024	<0.05	0.02	0.02	0.02		<0.01	<0.01
Total Kjeldahl Nitrogen (as N)	0.36	0.29	0.23		0.3	0.07	0.29	0.18	0.23	0.4	<0.2	<0.2	<0.2		0.6	1.0
Total Nitrogen (as N)	0.69	0.4	0.65		0.74	0.22	0.29	0.18	0.23	0.4	0.22	0.32	<0.2		1.8	1.9
TDS	10	10	11		15	<1	5	8	17	6.8	13	2.1	7		790	710

Silt Trap SW4

Test	15/04/10	19/05/10	28/06/10	11/11/11	14/12/11	12/04/12	27/03/14	24/09/14	24/01/17	1/11/17	21/06/19	10/10/19	10/12/19	14/07/22	26/09/22	16/12/22
Ammonia (as N)	N/A	N/A	N/A		N/A	N/A	N/A	N/A		<0.01	0.42	1.3	0.06		0.2	1.0
Nitrate & Nitrite (as N)	N/A	N/A	N/A		N/A	N/A	N/A	N/A		3.5	2.4	3.6	1.1		0.17	7.4
Nitrate (as N)	0.37	0.2	1		0.94	0.45	1.4	0.37		3.4	2.4	3.5	1.1		0.17	7.3
Nitrite (as N) 0.02 mg/L < 0.02	0.011	<0.003	0.009		0.009	0.006	0.005	0.04		0.07	<0.02	0.05	<0.02		<0.02	0.13
Organic Nitrogen (as N)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		0.9	<0.2	0.3	<0.2		0.5	1.3
Phosphate total (as P)	0.016	0.31	0.016		0.047	0.042	0.049	0.017		<0.05	0.02	0.02	0.01		0.02	0.30
Total Kjeldahl Nitrogen (as N)	0.23	0.36	0.37		0.41	0.14	0.44	0.24		0.9	0.6	1.6	<0.2		0.7	2.3
Total Nitrogen (as N)	0.61	0.56	1.4		1.4	0.6	1.8	0.65		4.4	3	5.2	1.1		0.87	9.7
TDS	16	84	34		10	10	72	11	N/A	34	22	2.1	2.4		2700	2700

Main Trib US Quarry SW5

Test	15/04/10	19/05/10	28/06/10	11/11/11	14/12/11	12/04/12	27/03/14	24/09/14	24/01/17	1/11/17	21/06/19	10/10/19	10/12/19	14/07/22	26/09/22	16/12/22
Ammonia (as N)		N/A	N/A		N/A	N/A	N/A	N/A	N/A	<0.01	0.02	<0.01	0.01	<0.01	0.08	<0.01
Nitrate & Nitrite (as N)		N/A	N/A		N/A	N/A	N/A	N/A	N/A	1.1	1.5	1.1	1.2	1.2	0.91	1.3
Nitrate (as N)		1	1.8		1.2	0.8	0.75	1	0.86	1.1	1.5	1.1	1.2	1.2	0.91	1.3
Nitrite (as N) 0.02 mg/L < 0.02		<0.003	<0.003		<0.001	<0.001	<0.001	<0.001	<0.001	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Organic Nitrogen (as N)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.6	<0.2	0.3	<0.2	<0.2	0.63	<0.2
Phosphate total (as P)		0.019	0.033		0.048	0.039	0.039	0.027	0.033	0.06	0.03	0.02	0.02	0.03	0.02	<0.01
Total Kjeldahl Nitrogen (as N)		0.25	0.48		0.36	0.04	0.13	0.19	0.24	0.6	<0.2	0.3	<0.2	<0.2	0.7	<0.2
Total Nitrogen (as N)		1.2	2.3		1.6	0.84	0.88	1.2	1.1	1.7	1.5	1.4	1.2	1.2	1.61	1.3
TDS		26	41		14	18	23	24	26	24	35	5.8	35	78	100	73

Ure Creek downstream SW6

Test	15/04/10	19/05/10	28/06/10	11/11/11	14/12/11	12/04/12	27/03/14	24/09/14	24/01/17	1/11/17	21/06/19	10/10/19	10/12/19	14/07/22	26/09/22	16/12/22
Ammonia (as N)	N/A	N/A	N/A		N/A	N/A	N/A	N/A	N/A	<0.01	0.02	<0.01	<0.01	0.11	0.07	<0.01
Nitrate & Nitrite (as N)	N/A	N/A	N/A		N/A	N/A	N/A	N/A	N/A	0.89	1.5	0.94	0.85	0.93	0.91	1.5
Nitrate (as N)	0.27	0.53	2		1.3	0.42	0.39	0.83	0.67	0.89	1.5	0.94	0.85	0.92	0.91	1.5
Nitrite (as N) 0.02 mg/L < 0.02	0.008	<0.003	<0.003		0.004	<0.001	0.003	<0.001	<0.001	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Organic Nitrogen (as N)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.6	<0.2	<0.2	<0.2	N/A	0.63	1.3
Phosphate total (as P)	0.008	0.008	0.013		0.017	0.021	0.53	0.014	0.012	<0.05	0.03	0.02	0.01	0.02	0.02	0.02
Total Kjeldahl Nitrogen (as N)	0.26	0.2	0.44		0.45	0.11	0.29	0.18	0.23	0.6	<0.2	<0.2	<0.2	<0.2	0.7	1.3
Total Nitrogen (as N)	0.54	0.73	2.4		1.8	0.53	0.68	1	0.9	1.5	1.5	0.94	0.85	0.93	1.61	2.8
TDS	4	9	10		8	<1	1000	18	4	24	57	6.4	12	98	100	230

APPENDIX B
MELBOURNE WATER PRE-DEVELOPMENT ADVICE APPLICATION

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