Sutton Forest Quarries Pty Ltd

ABN 66 158 999 994

Surface Water Assessment

Specialist Consultant Studies Compendium

Volume 1, Part 3

Prepared by

Strategic Environmental & Engineering Consulting (SEEC) Pty Ltd

February 2018

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Surface Water Assessment

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* Note: This figure was finalised prior to a late modification to the footprint of the northeastern barrier – the east-west section shown on this figure has been removed – see EIS Figure 2.1.

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EXECUTIVE SUMMARY

Strategic Environmental and Engineering Consulting (SEEC) Pty Ltd has been commissioned by Sutton Forest Quarries Pty Ltd ("the Applicant") to prepare this Surface Water Assessment for the proposed Sutton Forest Sand Quarry ("the Proposal"), via Sutton Forest, NSW.

As part of the proposed extraction activities, approximately 47ha would be progressively excluded from the local surface water catchments, thereby reducing the overall volume of runoff water within the catchment. However, the proposed extraction activities include the establishment of numerous ancillary facilities, many of which would create impervious or partly impervious surfaces. Those areas would result in increased surface runoff compared to the pre-development condition and these increases would partly offset the reductions in surface flow experienced as a result of the proposed extraction activities. Water balance and flow calculations demonstrate the overall change would be minimal and would be difficult to discern in the receiving waters.

Surface water would be harvested from two harvestable right dams within the Site Boundary for processing and dust suppression. Modelling indicates that, on average, and at peak production, approximately 33ML/yr of make-up water from other sources would be required to address the shortfall between demand and available water in harvestable right dams during average rainfall years. During lower-than-average rainfall years, the shortfall between demand and available surface water would be greater. The Applicant proposes to secure access to additional water sources, either through the acquisition of existing allocations or commercial agreement.

Soil and surface water impacts would be managed through the adoption of the requirements of relevant best-practice guidelines to minimise the risk that surface runoff from the Site might cause undue pollution of local watercourses. A plan for water quality monitoring, plus associated response plans, is included to ensure the effectiveness of these measures.

Domestic wastewater generated at the site office and processing area would be treated and disposed on site in accordance with the relevant best-practice guidelines such as AS/NZS 1547:2011.

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1. INTRODUCTION AND PROJECT DESCRIPTION

1.1 SCOPE

Strategic Environmental and Engineering Consulting (SEEC) Pty Ltd has been commissioned by RW Corkery & Co Pty Limited on behalf of Sutton Forest Quarries Pty Ltd ("the Applicant") to prepare this Surface Water Assessment for the proposed Sutton Forest Sand Quarry Project ("the Proposal"), via Sutton Forest, NSW (**Figure 1**) ("the Site").

For the purposes of this document, the Proposal would be undertaken within an area referred to as "the Site" (see **Figure 1**). The Site incorporates the Quarry Operations Area, i.e. the area in which all extraction, processing and related activities would be undertaken. Access between the Quarry Operations Area and the Hume Highway would be via a 1.4km long quarry access road.

This report provides:

- background on the existing surface water environment at, and in the vicinity of, the Site, including rainfall and runoff characteristics;
- an assessment of the availability of surface water for the Proposal's operational requirements;
- an assessment of the likely surface water impacts of the Proposal; and
- a conceptual integrated water management strategy that incorporates recommended management and mitigation measures to address potential surface water-related impacts.

In conducting this assessment, SEEC has:

- conducted a review of the existing surface water conditions within the Site and within its local context;
- obtained and analysed available rainfall data;
- conducted a field survey of the landforms, topography, drainage and soils within the Site and its surrounds;
- modelled the existing site hydrology and runoff/infiltration characteristics;
- prepared a Surface Water Balance for the Proposal, based on anticipated water demand figures as provided by the Applicant; and
- reviewed and recommended water quality targets and triggers that would apply to the Proposal.

The following Legislation, Policies and Guidelines have been referenced during the compilation of this assessment:

- NSW Office of Environment and Heritage's *Managing Urban Stormwater Series*:
  - Soils and Construction, Volume 1 (Landcom, 2004)
  - Soils and Construction Volume 2a: Installation of Services
  - Soils and Construction Volume 2c: Unsealed Roads
  - Soils and Construction Volume 2e: Mines and Quarries
- Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC, 2000).

- Water Management Act 2000:
  - Harvestable Right Provisions.
  - Water Sharing Plan for the Greater Metropolitan Region Unregulated River Water Sources.

1.2 OVERVIEW OF THE PROPOSAL

The proposed extraction and processing areas, as shown on **Figure 1**, have been defined based upon the occurrence of friable sandstone within the quarry operations area, and taking advantage of the local topography that would provide long term protection to control the propagation of noise to the south and limit the visibility of operational areas from the adjoining properties and the Hume Highway. An estimated 34 million tonnes of friable sandstone has been defined within the proposed extraction area and the footprint of the processing and stockpiling area. This resource is capable of yielding approximately 29 million tonnes of high quality sand products. Negligible overburden is present within the proposed extraction area as the friable sandstone in a number of areas lies directly beneath the soil.

A fixed wash plant and mobile screening plant would be used to process the extracted raw sand to produce high quality sand products meeting nominated Australian Standards and customers' individual specifications. The principal products produced would be various grades of washed concrete sand and mortar (brickie's) sands. The fixed wash plant would be used to produce concrete sand and blended products whereas the mobile screening plant would be used to produce brickie's sand products.

The sand extraction and processing operations have been designed to optimise the recovery of sand whilst satisfying both site and surrounding environmental constraints and progressively backfilling the extraction void with the residual fines from the processing operations together with Virgin Excavated Natural Material (VENM) and Excavated Natural Material (ENM) to create a free draining final landform with features that would support the ongoing agricultural and nature conservation land uses.

Figure 2.1 displays the following principal components of the Proposal.

- An extraction area covering approximately 47ha with its footprint typically between 660m AHD and 700m AHD.
- A processing and stockpiling area covering approximately 12ha incorporating a fixed wash plant involving washing, screening, dewatering and product stockpiling beneath radial and fixed stackers.
- Two mobile brickie's sand plants would ultimately be located within the northern part of the processing and stockpiling area and/or close to the active extraction area.
- A temporary topsoil and mulch stockpile area within the footprint of the extraction area for the storage of topsoil recovered from the early extraction stages and mulched timber from the areas cleared.
- Two fines storage areas to contain fines produced from the sand washing process during the first three stages of extraction.

- Two water storage dams located to the east and west of the processing and stockpiling area to provide water for dust suppression as well as a supplementary supply for the wash plant.
- A diversion drain along the southern boundary of the proposed Quarry Operations Area to divert runoff away from operational areas and capture for reuse in processing and dust suppression.
- The site weighbridge and office would be positioned adjacent to the processing and stockpiling area. One weighbridge would be constructed initially with provision for a second weighbridge, as production ramps up in the future.

The overall operational footprint would be kept as small as practicable and ultimately rehabilitated to provide for ongoing agricultural land uses and long-term nature conservation and wildlife corridor values within the local area.

Access to and from the quarry operations area would be from the Hume Highway via the quarry access road (**Figure 1)**.

Product despatch would involve the use of truck and dog trailers (tri and quad axle) as well as some higher mass limit and rigid trucks.

The Applicant proposes to commence production at an initial extraction rate of approximately 250 000tpa (yielding approximately 220 000tpa of sand products) increasing to an average extraction rate of 820 000tpa (yielding approximately 700 000tpa of sand products). The maximum extraction rate proposed is 1Mtpa which would yield approximately 860 000tpa of sand products.

The defined sandstone resource would be extracted in a staged manner, i.e. over eight extraction stages (Stages 0 to 7). The development consent currently being sought would enable extraction of the resource until Year 30. Assuming an average rate of extraction is maintained extraction Stage 5 would be completed by Year 30. The completion of the subsequent extraction stages (Stages 6 and 7) would require an additional development consent beyond Year 30.

The Site would be progressively rehabilitated in a manner that would provide long-term nature conservation and wildlife corridor values of the local area together with some agricultural/horticultural opportunities for the landowner.

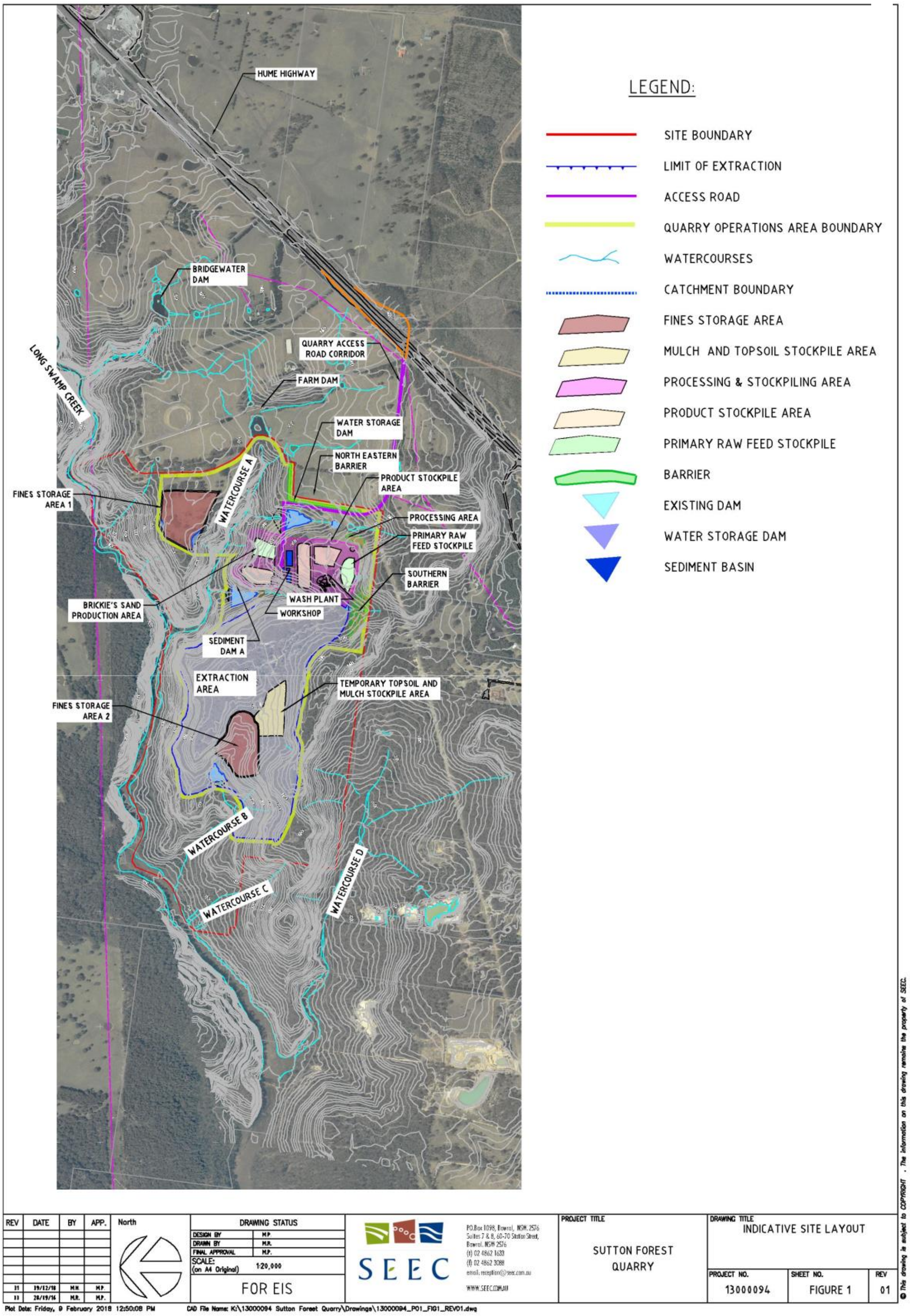

Figure 1 – Site Location and Layout of the Proposal

2. ENVIRONMENTAL SETTING

2.1 TOPOGRAPHY AND SOILS

2.1.1 Quarry Operations Area

The access road, extraction area, processing and stockpiling area, the two fines storage areas, the temporary topsoil and mulch stockpile and the visibility barriers predominantly lie on the Larkin, Soapy Flat and Penrose Soil Landscapes (SCA/DLWC, 2002). The distribution of these soil landscapes within and surrounding the Site are detailed in SEEC (2018). These areas are characterised mainly by gently undulating rises and undulating low hills with slope gradients between 2% and 10%, except in the northern part of the extraction area where slopes are up to 25% on the Nattai Tablelands Soil landscape.

2.1.2 The Quarry Access Road

The quarry access road and its interchange with the Hume Highway would predominantly be on the Larkin Soil Landscape, with a minor occurrence on the Penrose Landscape. The proposed alignment is mostly along gently undulating rises to undulating low hills with slope gradients between 2% and 10%.

2.2 DRAINAGE AND RECEIVING WATERS

2.2.1 General Description

The extraction area predominantly occupies a ridge and crest between two watercourses (**Figure 2**). Long Swamp Creek is a fourth order watercourse which lies to the north and west of the Site. A range of watercourses drain into Long Swamp Creek to the north and west of the proposed operational areas. For the purposes of this report, four of these watercourses have been described as Watercourses A, B, C and D (**Figure 2**). A small section of the proposed Quarry Interchange would be situated in the catchment of Hanging Rock Swamp, however no watercourses are mapped in the vicinity of the proposed interchange (**Figure 2**).

The proposed water storage dams are located on first order watercourses that flow into Watercourse A and then northwards to Long Swamp Creek. The proposed Quarry Access Road crosses one of these first order watercourses via the embankment of Water Storage Dam A.

All watercourses within the Site are identified as intermittent (i.e. not perennial) streams on the Canyonleigh 1:25 000 topographic map (**Figure 2**).

Long Swamp Creek has a catchment of approximately 19km^2 to a point just downstream of the extraction area, i.e. where Watercourse B enters Long Swamp Creek. Long Swamp Creek experiences sustained levels of flow as a result of groundwater flows through the landscape (Larry Cook and Associates, 2016) and, as a result, carries flow for the majority of the year. At the times of inspection by SEEC staff (August 2013 and March/April 2014), Long Swamp Creek was observed to be flowing, although much of the flow west of the extraction area was through thick reed beds (**Figure 3**).

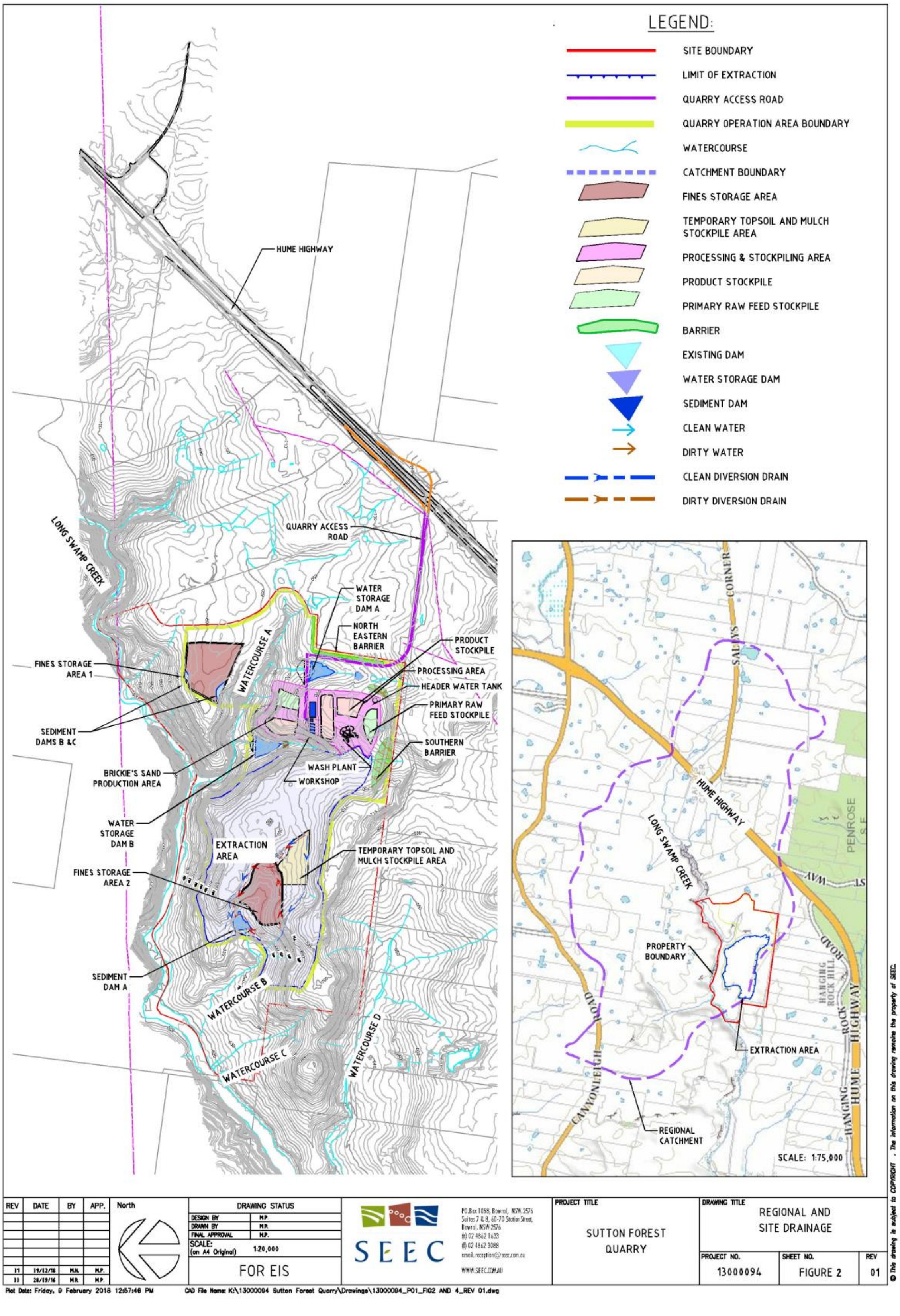

Figure 2 – Regional and Site Drainage

Figure 3 – Long Swamp Creek west of the extraction area looking downstream

2.2.2 Watercourse Classification

The entire Site ultimately drains into Long Swamp Creek, a slightly disturbed upland stream within the Hawkesbury-Nepean Catchment of NSW. It also lies within Sydney's Drinking Water Catchment, which is administered by Water NSW, formally the Sydney Catchment Authority (SCA).

2.2.3 Surface Water Sharing Plan

The Water Sharing Plan for the Greater Metropolitan Region Unregulated River Water Sources, 2011 applies to the Site. This is discussed in Section 5.2.

2.2.4 Existing Water Quality

Three water quality testing locations were established on Long Swamp Creek during the compilation of this Surface Water Assessment. **Figure 4** and **Table 1** detail these locations.

Table 1 – Location of Surface Water Quality Monitoring Sites

Identifier	Location (Lat/Long)	Comment
WQL1	-34.607875°, 150.188507°	On Long Swamp Creek, upstream of the extraction area and processing and stockpiling area.
WQL2	-34.610070°, 150.184991°	On Long Swamp Creek, immediately downstream of the extraction area above the junction with Watercourse B.
WQL3	-34.606744°, 150.203656°.	On Long Swamp Creek, downstream of the extraction area and downstream of the junction with Watercourse C that lies to the south of the extraction area.

Two rounds of water quality sampling and testing were undertaken during the preparation of this Surface Water Assessment in August 2013 and March/April 2014. The results of the water quality testing are presented in **Table 2.** These results show that water quality in Long Swamp Creek is mostly consistent with the ANZECC (2000) guidelines. Waters are not saline and there are no exceedances of the ANZECC Toxicity Triggers. However, some variance from the Stress Indicators in ANZECC (2000) guidelines was identified as follows.

- pH values lower than 6.5 in March/April 2014.
- Dissolved Oxygen levels significantly lower than 90% on both occasions.
- Total Nitrogen concentrations were higher than 250µg/L on both occasions.

Table 2 – Water Quality Test Results and Trigger Values

Pollutant/parameter	Measured Values (August 2013)			Measured Values (March/April 2014)			Trigger Value*
	WQL1	WQL2	WQL3	WQL1	WQL2	WQL3	
pH	7.5	7.4	7.1	6.3	6.3	5.5	>6.5 and <8
Electrical Conductivity (µS/cm)	221	211	295	314	268	125	350
Total Phosphorous (µg/L)	0	0	10	0	0	20	20
Total Nitrogen (µg/L)	600	900	850	300	300	260	250
Dissolved Oxygen (%)	57	53	40	38	47	54	<90 or >110
Alkalinity ($CaCO_3$) (mg/L)	37	31	58	49	32	24	NA
Total Suspended Solids (mg/L)	0	0	0	7.5	0	0	Site-specific equivalent to <25NTU

* Trigger values from ANZECC (2000).

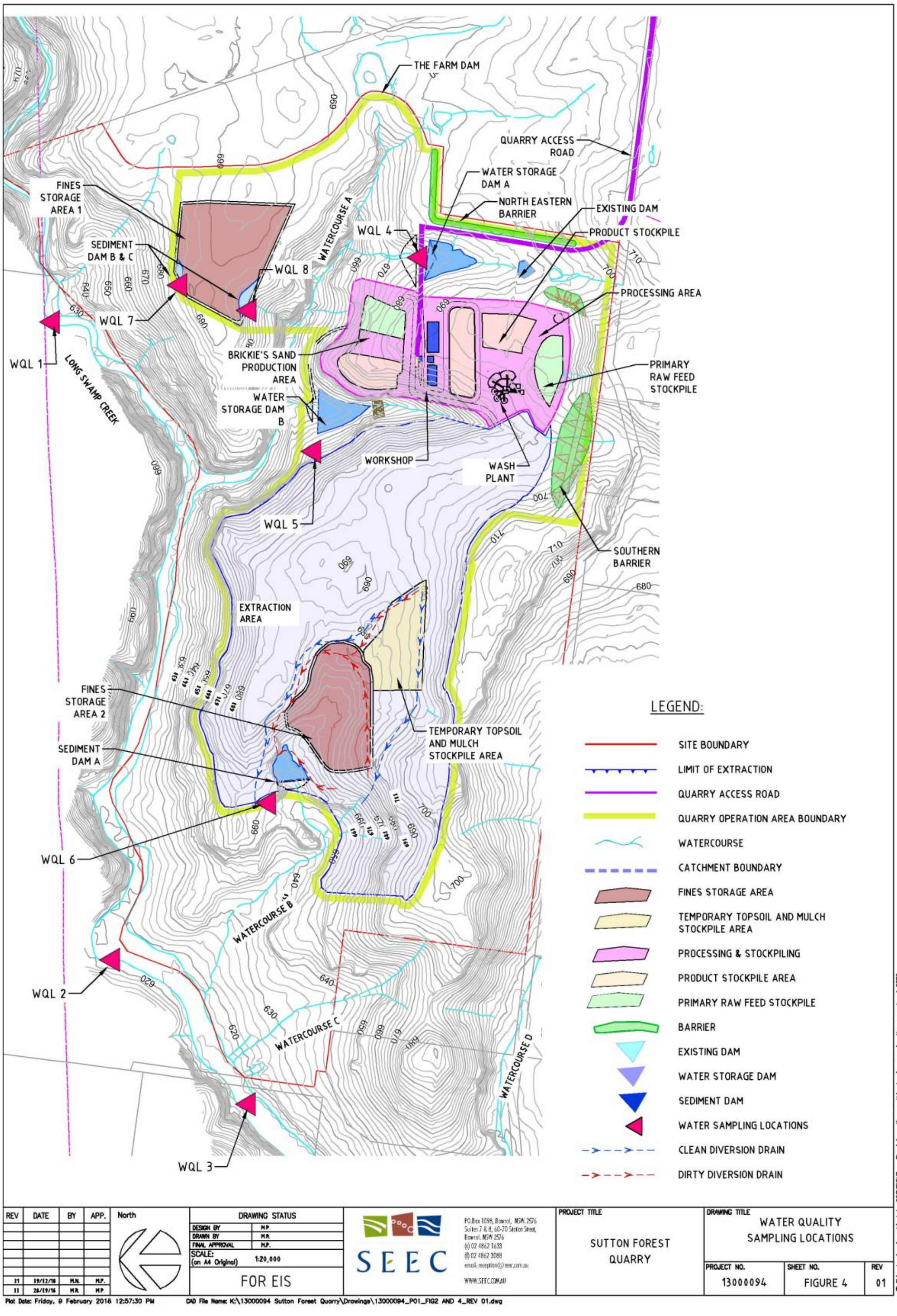

Figure 4 – Water Quality Sampling Locations

2.2.5 Existing Dams

There are no existing dams in the extraction area, and only one small (approximately 1 ML) dam within the boundary of the Quarry Operations Area. The dam's location, together with others on adjoining lands, is shown in **Figure 2.** The total estimated volume of existing dams within the site boundary is, therefore, 1ML.

2.2.6 Surface Water Runoff Coefficients

2.2.6.1 Natural Lands

The most accurate method of estimating the mean surface water volumetric runoff coefficient (C_v, the percentage of rainfall that flows off a natural site as surface flow) is to use calibrated data from nearby or similar catchments (Boughton, 2003). Unfortunately, there are no monitoring stations on the receiving waters and none within an appropriately close proximity.

However, given the Site's topographic location, and the soil landscapes present, the estimated C_v is 0.08 in all areas of the Site except the eastern sections of the Quarry access road where the estimated Cv is 0.12.

Therefore, for most of the Site approximately 8% of incident rainfall would become surface runoff and it is assumed that the remainder would be lost to evapotranspiration or infiltrated to groundwater. Of these, the former is predicted to be the most significant due to the presence of the existing vegetation cover over the bulk of the Site.

The C_{10} runoff coefficient (10-year average recurrence interval (ARI) rainfall event) for natural lands in this location is 0.6 (Institute of Engineers Australia, 2003).

The estimated mean annual flow in Long Swamp Creek at WQL3 (**Figure 4**) *that is attributable to surface water* runoff is approximately 2,050ML/year This is calculated from an overall catchment of 19km^2 , a mean rainfall of 902 mm/year and an overall C_v of 0.12. Note that actual flows in Long Swamp Creek at WQL3 would be higher due to groundwater inputs. Details relating to this are contained in the Groundwater Impact Assessment (Cook, 2016).

2.2.6.2 Disturbed Lands

Lands that are stripped of vegetation and subject to compaction by earthmoving equipment experience significantly higher runoff coefficients than more natural, pervious areas. In the extraction and operational areas the existing soils are essentially deep sands. These areas are recognised as having high to very high infiltration capacities and belong to Hydrological Group B (Landcom, 2004 and SCA/DLWC, 2002). For disturbed lands on these soils, Landcom (2004) suggests:

- a volumetric coefficient of runoff (C_v) of 0.57[1] ; and
- a C_{10} runoff coefficient (for disturbed land) of 0.58[2].

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[1] For the 95th percentile 5-day rainfall depth of 68.4 mm.
[2] For the 10-year 1-hour storm event (40mm)

2.3 CLIMATE

2.3.1 Site Rainfall Data

An automatic weather monitoring station is located on the Site, close to the proposed processing and stockpiling area (**Figure 1**). This monitoring station has only been in operation since November 2012 so reliable rainfall long-term averages cannot be determined from it. However, it would continue to be used during the establishment and operational phases of the Proposal to monitor and report on daily rainfall as part of the Annual Review.

High-quality, extended-duration rainfall data is available from a number of nearby Bureau of Meteorology (BoM) Weather Stations. For the purposes of modelling and analysis of climate, these data have been used (refer to Section 2.3.2).

2.3.2 Daily Rainfall Data

There are a number of BoM Weather Monitoring Stations within the vicinity of the Site (**Table 3**). Of these, Eling (Station 68093) is the closest and Moss Vale (Station 68045) is the furthest (**Figure 5**). Note that, despite its relative distance from the Site, Moss Vale is included as it is still open and is able to provide data post 1980, which other stations cannot.

Table 3 – Local BoM Rainfall Stations

Station Name and Number	Location	Approximate distance to Extraction Area	Date Station Opened	Year Station Closed	Mean Annual Rainfall (mm)	Data Complete-ness %
Eling 68093	34.57S 150.26E	8km	1945	07/04/2004	898.5	91
Sutton Forest (Uralba) 68058	34.57S 150.35E	10km	1901	31/12/1966	877.7	95
Sutton Forest (Cherry Tree Hill) 68075	34.55S 150.27E	15km	1956	31/12/1980	923.3	99
Moss Vale 68045	34.54S 150.38S	18km	1870	Open	961	97

Composite daily and monthly rainfall records were compiled using the most reliable and complete data available from the datasets detailed in **Table 3**. Wherever possible, data from Eling (06093) were used to create the rainfall records. Isolated missing data within the Eling (06093) dataset were replaced with zeroes. However, where extended periods without data occurred, these were filled in using data from Uralba (Station 68058), or, if that was not possible, from Cherry Tree Hill (68075). Significant gaps in the Eling (06093) record occur between February 1956 and June 1959 (inclusive), the whole of December 1959 and for the whole of 1994. The last year with reliable daily data was 1999. Minor gaps after 1980 and the whole of 1994 were filled using data from Moss Vale (68045). Although Moss Vale (68045) also has data available after 1999, it was not considered sufficiently representative to cover such an extended period due to its relative distance from the Site. Therefore, the daily rainfall data presented, and used in modelling, finishes at the end of 1999.

The composited daily rainfall graph since 1945 is shown in **Figure 6**. The data (which is used for modelling in Section 5.5) is summarised in **Table 4.**

Table 4 –Rainfall and Potential Evapotranspiration Statistics (Composited Data)

	Statistics						
	mean	**median**	**maximum**	**minimum**	**10%ile**	**90%ile**	**mean annual (mm)**
Rainfall (daily steps)	2.47	0	170.8	0	0	6.8	902
Areal Potential Evapo-transpiration (PET) (mm/day)[3]	3.19	2.76	5.23	1.26	1.28	5.11	1167

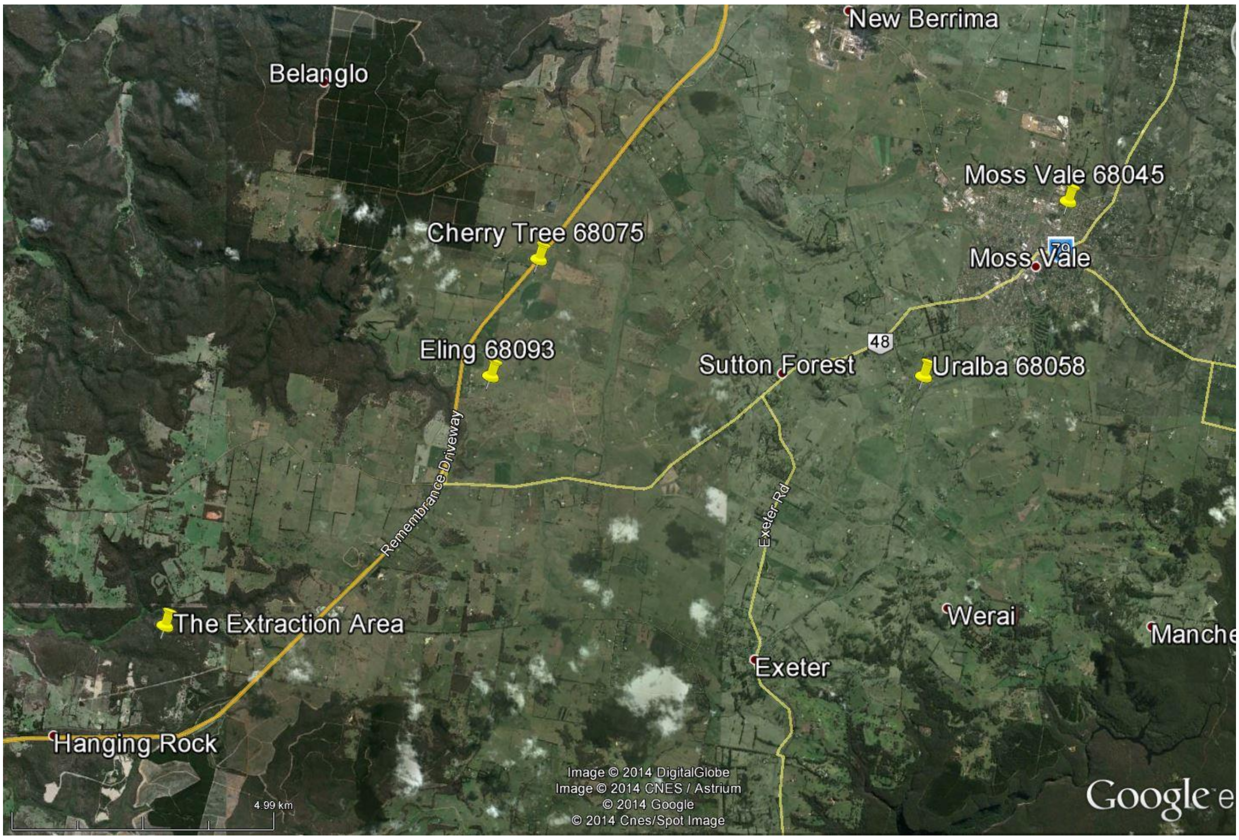

Figure 5 – Rainfall Stations

[3] Evaporation from a pond surface is taken as 1.5 times the PET.

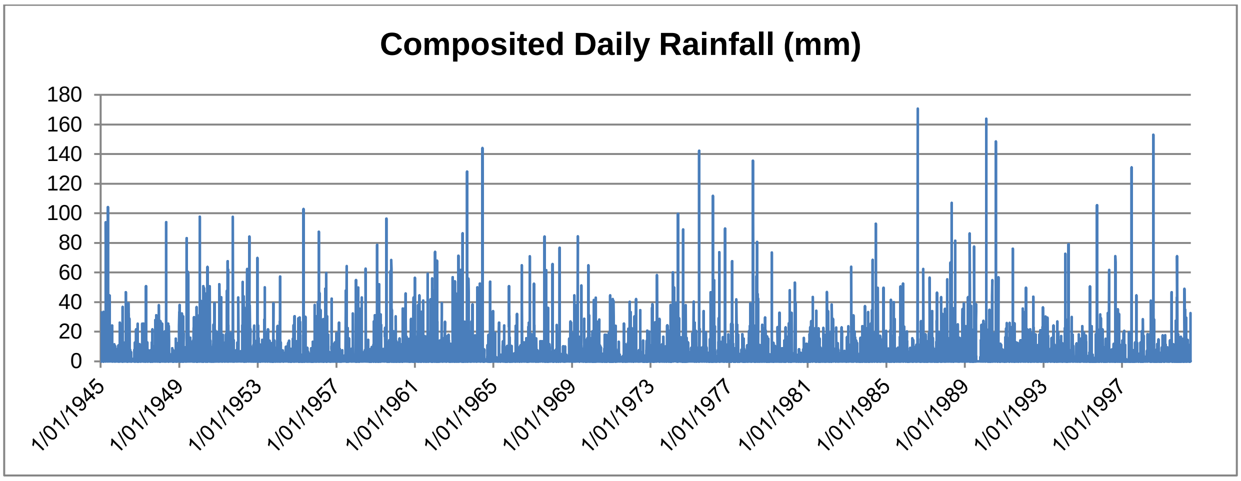

Figure 6 – Composited Daily Rainfall Data

2.3.3 Monthly Rainfall Data

The composited monthly rainfall data from 1945 is shown in **Figure 7**. The process for developing this data is detailed in Section 2.3.2.

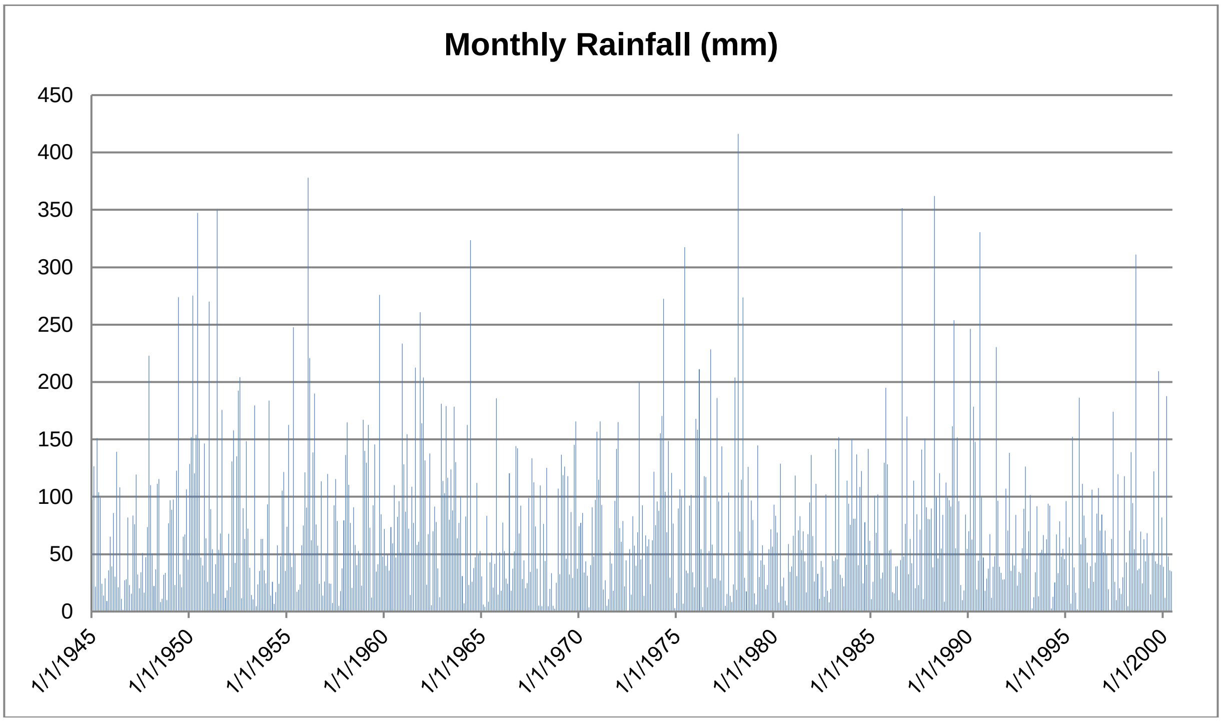

Figure 7 – Composited Monthly Rainfall Data

2.3.4 Annual Rainfall Data

Composited annual rainfall data is shown in **Figure 8**. The process for developing this data is detailed in Section 2.3.2.

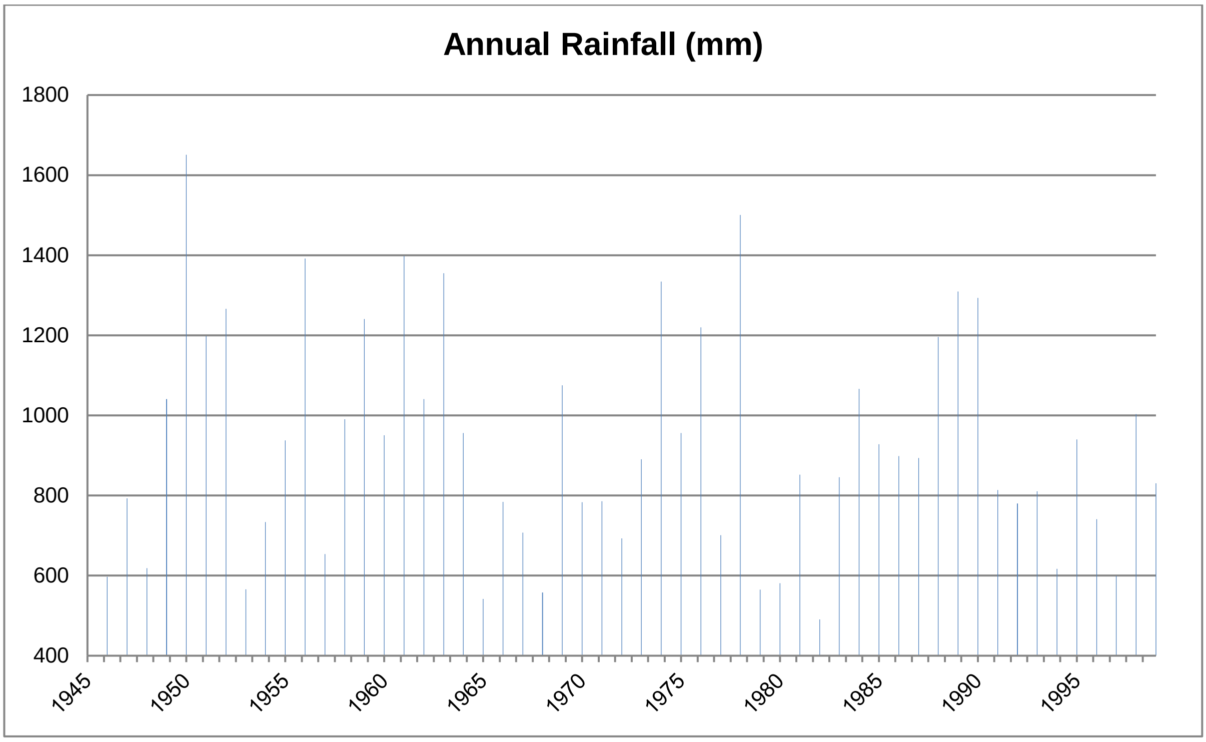

Figure 8 – Mean Annual Rainfall

2.3.5 Intensity-Frequency-Duration Data

The Intensity-Frequency-Duration (IFD) chart is given in **Figure 9** (BoM, 2016). It is used for sizing drains, spillways and Type C sediment basins (Section 3.2.2.2). It is also used to calculate the Site's R-Factor (rainfall erosivity factor), which is part of predicting erosion hazard[4].

[4] Although there is new IFD data for use with ARR2016, Landcom (2004) uses the old IFD data to size sediment basins, drains etc. and to calculate the R-Factor. At the time of writing Landcom (2004) had not been updated to use the new ARR2016 system.

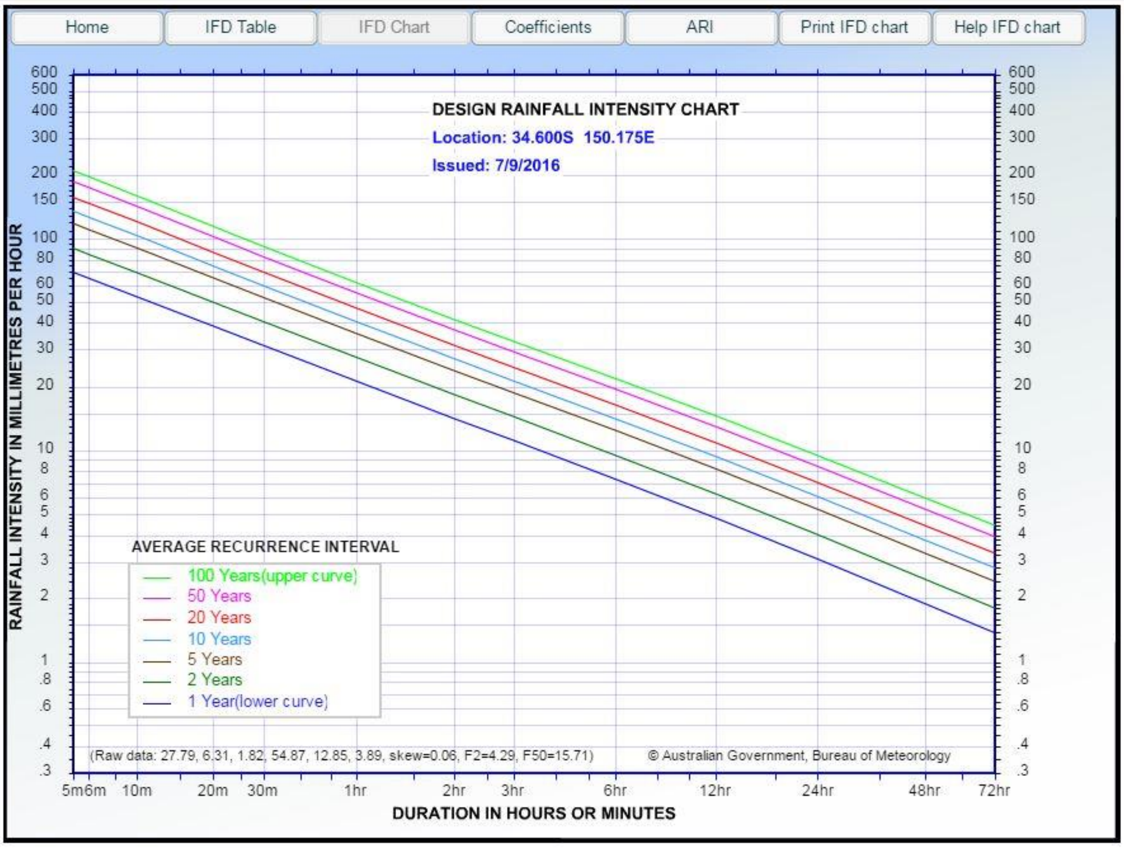

Figure 9 – IFD Chart

2.3.6 Pluviograph Data

This data is presented in six-minute time steps and consequently is different to the daily and monthly data presented in Sections 2.3.2 and 2.3.3**.** The data set used here is “Zone 3" data supplied by the Water NSW (formerly Sydney Catchment Authority). Basic rainfall and potential evapotranspiration (PET) statistics are in **Table 5** and the time-series graph is in **Figure 10**.

Table 5 – Rainfall and Potential Evapotranspiration Statistics for Water NSW Zone 3

	Statistics						
	Mean	**Median**	**Maximum**	**Minimum**	**10th Percentile**	**90th Percentile**	**Mean Annual (mm)**
Rainfall (mm/6 minute steps)	0.01	0	12.5	0	0	0	883
Areal PET (mm/day)	3.094	2.7	4.97	1.27	1.35	4.74	1130

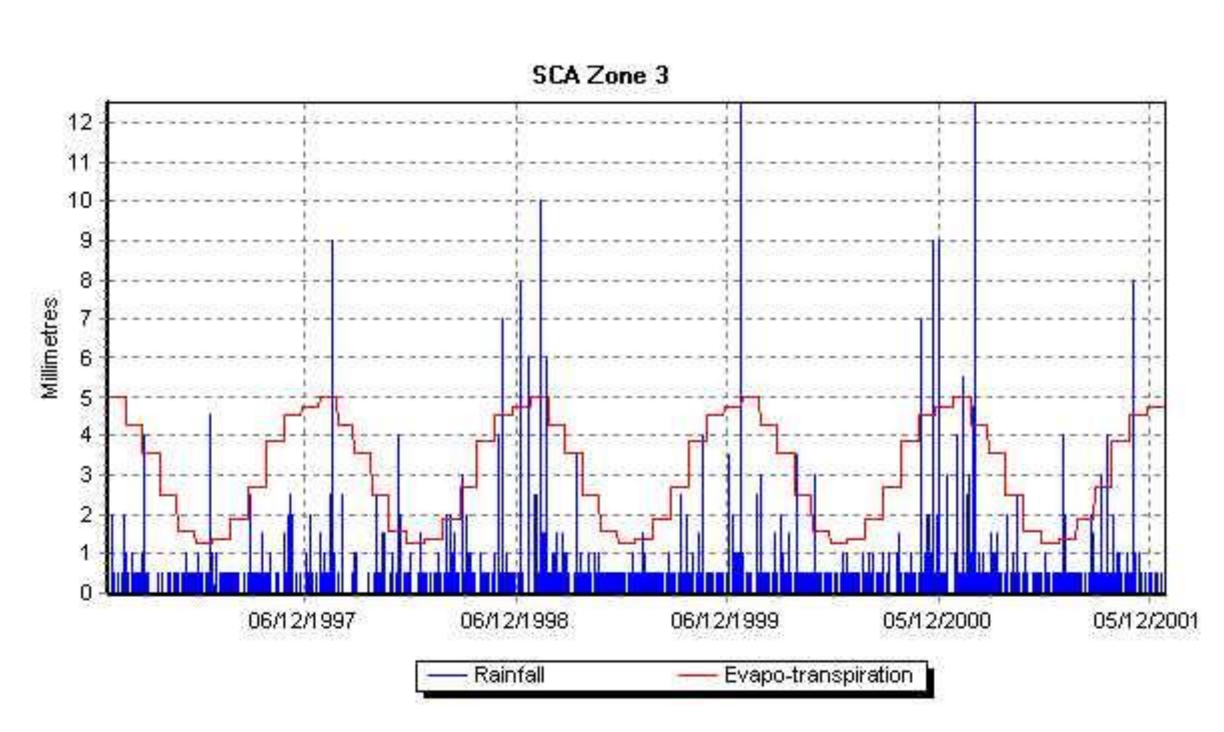

Figure 10 – Pluviograph Rainfall (6mm steps) and mean Potential Evapotranspiration statistics

2.3.7 Rainfall Erosivity (R-Factor)

The R-Factor is an estimate of the erosive potential of rainfall. It is derived from the 2-year ARI, 6-hour rainfall event for a site, (Landcom, 2004). For the Quarry Operations Area, it is 2,040 which is low to moderate.

3. SURFACE WATER IMPACTS

3.1 SURFACE WATER VOLUMES

3.1.1 The Extraction Area

The proposed extraction area covers approximately 39.1ha, all of which drains to Long Swamp Creek. The proposed extraction area is presently well-vegetated and the soils are Hydrological Group B with an estimated volumetric coefficient of runoff (C_v) of 0.08 (Section 2.2.6.1). This equates to an existing mean annual surface flow volume of approximately 34ML/year from this area which represents approximately 1.7% of the estimated mean annual flow in Long Swamp Creek attributable to surface runoff.

Clearing and compaction would progressively occur over the Quarry Operations Area. As a result, the estimated volumetric coefficient of runoff (C_v) could progressively rise to 0.57 in high rainfall events (Landcom, 2004).

Runoff from the extraction area during Stage 1 of the extraction process (**Figure 11**) would continue as it is presently with appropriate sediment controls (e.g. sediment basins/sumps) used to manage potentially sediment-laden runoff from the extraction area prior to it draining into Long Swamp Creek (Section 3.2.4.1). Runoff from Stage 1 (7ha) would drain towards Long Swamp Creek and, as such, surface flows into Long Swamp Creek would increase marginally as surfaces are cleared and compacted[5].

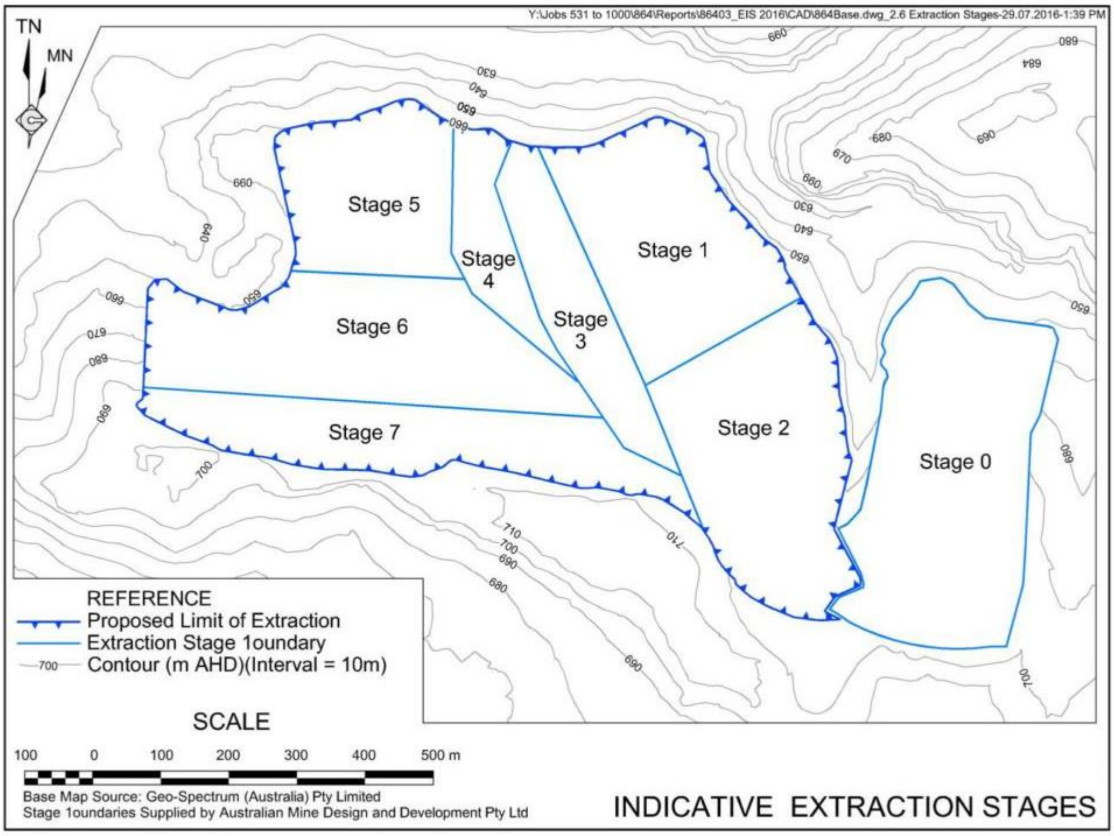

Figure 11 – Extraction Stages

[5] A proportion of the runoff collected in the sumps in the extraction area would be used for dust suppression.

However, after Stage 1 of the extraction process, the extraction area would become internally-draining and there would a progressive reduction in surface flow to Long Swamp Creek as the successive stages are developed. After Stage 1, there would be no direct surface water runoff from the extraction area. As a result, the total surface runoff volume from the proposed extraction area catchment would decrease compared to the existing conditions. However, this would be potentially offset by increases in infiltration to groundwater, as previous losses due to plant evapotranspiration would no longer occur in those areas that are cleared.

3.1.2 Processing and Stockpiling Area

The processing and stockpiling area would occupy approximately 12ha, much of it (approximately 75%) as compacted hardstand. Raw feed (of friable sandstone) would be recovered from within the footprint of the processing and stockpiling area during the first 3 years of the Quarry's operation (Extraction Stage 0). Surface flow would progressively increase in this area compared to the existing conditions as a result of clearing and compaction. Surface water runoff from the processing and stockpiling area could potentially contain significant quantities of sediment and, as a result, would be directed through sediment traps prior to flowing into two water storage dams where it would be re-used for on-site purposes such as sand washing and dust suppression. Sediment trapped in the sediment traps would be reclaimed for processing/sale.

The water storage dams would also have pervious (clean water) catchments totalling approximately 21ha. Hydrological modelling shows there would be a net decrease in mean annual surface flow to receiving waters from this overall catchment of about 6ML/year as a result of the quarry activities.

3.1.3 Barriers

Areas to be used for the barriers lie to the south, east and northeast of the processing and stockpiling area. During construction of the barriers, there would be an increase in surface runoff compared to the existing conditions. However, any changes in runoff volumes would be short-term because the barriers would be quickly re-vegetated. As a result, long-term surface water runoff volumes from the lands to be used for the southern and eastern barriers would not change significantly.

3.1.4 Quarry Access Road

The quarry access road would be approximately 1.4km in length, with a 7.5m wide sealed pavement, two 0.75m wide compacted gravel shoulders and adjacent table drains all contained within a road corridor approximately 10m wide. The design of the quarry access road requires some minor excavation of material, possibly into the underlying weathered rock. There would also be some minor filled embankments.

An assessment of the proposed road design suggests that approximately 45% of its area would be effectively impervious. This would result in an increase in runoff when compared to the existing conditions. The management of potential increases in surface flow from the quarry access road is discussed in detail in Section 3.2.4.3.

3.1.5 Fines Storage Areas

There would be two fines storage areas (FSA).

- FSA 1 would be located north of the processing area and occupy up to 4ha (**Figure 13**).
- FSA 2 would be located on land that would ultimately become Stages 6 and 7 of the Extraction Area (**Figure 14**) and occupy up to 3.5ha.

Runoff from the fines storage areas would drain to sediment basins designed for the 95th percentile 5-day rainfall depth of 68.4 mm (DECC, 2008a and Landcom, 2004). These basins would trap sediment-laden runoff up to the design rainfall event to allow for settling of fine material (either via natural sedimentation or assisted settling using flocculation or coagulation) before release to the receiving environment.

All existing vegetation would be removed from the fines storage areas and, as such, the runoff coefficient (Cv) would rise from about 0.08 to up to 0.70[6] in high rainfall events (Landcom, 2004).

3.1.6 Soil and Mulch Stockpiling Area

A stockpiling area would be located immediately east of FSA 2, i.e. on land that would ultimately become Stages 6 and 7 of the extraction area (**Figure 12**). All existing vegetation would be removed from the stockpiling area and, as such, the runoff coefficient (Cv) could rise from about 0.08 to about 0.57 in high rainfall events (Landcom, 2004).

3.1.7 Summary of Surface Flow Changes

During Stage 1 of the extraction process, while runoff from the active extraction area could continue to flow to the receiving environment, there would be a small net increase in mean annual surface flow to Long Swamp Creek compared to the existing conditions. However, once the extraction area becomes internally-draining after Stage 1, the net increase would reduce. Given that Long Swamp Creek has a catchment of approximately 19km^2 and its base flow is predominantly fed by groundwater, neither of these increases in surface flow are likely to represent a significant change.

3.2 SURFACE WATER QUALITY

3.2.1 Introduction

No chemical processes are required for processing and producing the sand products as part of the Proposal. As such, potential pollutants are limited to the following:

- Sediment:
  - Soils exposed during either the establishment or the operational phases could become entrained in surface runoff.

[6] The stored soils would be fine grained

  - Sediment could be mobilised from unsealed hardstands, stockpiles, the fines storage areas and the quarry access road, its associated batters and drains.
  - Fine materials would be produced as a by-product of the sand processing.
- Possible fuel/oil spills; and
- Domestic wastewater (sewage).

A Water Management Plan would be prepared by a suitably qualified person and will address both the establishment and operational phases of the Proposal. The assumptions and calculations contained herein (particularly regarding sediment basin design) would be reviewed at that time and adopted in the relevant plans, as required. Note that project-specific conditions of development consent may necessitate modifications to these assumptions and calculations.

3.2.2 Design Rainfall Events

3.2.2.1 Introduction

DECC (2008a) requires sediment basins, their spillways, temporary drainage controls and temporary sediment controls to be designed to various design rainfall events depending on:

- the length of time they are operational;
- the type of soil present within their respective catchments (in the case of sediment basins);
- the time taken to treat and/or appropriately remove, the water (in the case of Type F/D sediment basins); and
- the sensitivity of the receiving waters[7].

3.2.2.2 Sediment Basins

There are two types of sediment basins described in Landcom (2004).

- A Type F/D (fine/dispersible) basin, also known as a wet basin. This type of basin is designed to trap a volume of water in a specific storm event so that it may be treated before release. A wet basin is used where the catchment comprises fine (silt and clay) or significantly dispersible soils. These types of basins often require chemical treatment of water using a coagulant or flocculent (e.g. gypsum).
- A Type C (coarse) basin, also known as a dry basin. This type of basin is designed to slow down flows sufficiently to allow natural settling and/or filtration of soil particles before the water is self-released to receiving waters. It is used where the catchment comprises coarse (sandy) soils.

[7] The receiving water (Long Swamp Creek) is in Sydney’s drinking water catchment and is therefore considered “sensitive”.

Regardless of the design parameters, the aim of any sediment basin is to manage the release of stormwater to a specific water quality in all rainfall events up to and including a nominated design rainfall event. Appropriate water quality limits are discussed further in Section 6.4.

SEEC (2018) includes detailed descriptions of the soils across the Site. Soils within the extraction and processing and stockpiling areas, and the quarry access road, are Type C soils and so sediment basins here would most likely[8] be Type C (dry) basins. Soils at the fines storage areas would be Type F soils. Sediment basins used to manage runoff from those areas would be Type F/D (wet) basins.

In the case of the fines storage areas, the length of time they would be operational likely exceeds three years and so the Type F/D sediment basin(s) would be designed for the 95th percentile 5-day rainfall depth, which is calculated from the daily rainfall data as 68.4mm.

All other catchments would most likely utilise Type C sediment basins, designed for the 2-year ARI design rainfall event, which would be calculated based on the catchment size draining to each sediment basin.

Spillways on all basins would be designed and stabilised to safely pass the 100-year ARI design rainfall event, which would be determined in each case by the catchment size.

3.2.2.3 Temporary Drainage Controls

Temporary drainage controls would generally be designed for the 20-year ARI design rainfall event, which would be determined by the catchment size. However, this may be reduced to the 10-year ARI event for the quarry access road construction because the timeframe for land disturbance and soil exposure is shorter than in other areas.

3.2.2.4 Temporary Sediment Controls

Temporary sediment controls (e.g. sediment fence, sediment traps) would generally be designed to be stable in the 20-year ARI design rainfall event, which is determined by catchment size. However, this may be reduced to the 10-year ARI event for the quarry access road construction because the timeframe for land disturbance and soil exposure is shorter than in other areas.

3.2.3 Sediment Control – Site Establishment and Construction Stage

3.2.3.1 Extraction Area

The extraction area would be developed as a series of stages (**Figure 11**). Establishing the first stage would require one or more Type C sediment basins to collect and treat runoff during initial clearing and stripping. However, as the stages progress, the active extraction areas would become internally draining. Refer to Section 3.2.4.1 for details.

[8] "Most likely" because, although the soils are identified as Type C soils, soil variability on site might mean a Type C basin may not achieve the required water quality outcome. If it can't, a wet type basin, and its appropriate management, would be required.

3.2.3.2 Processing and Stockpiling Area

During site establishment, this area would drain to a series of sediment traps and thence to the water storage dams all of which would be constructed early as part of site establishment and construction stage. The two water storage dams would be constructed first and both would have a storage capacity of 6.9ML (Section 5.4.1). The sediment traps would be established close to the main sources of sediment (**Figure 12**). Sediment in the sediment traps would be regularly removed and processed as product once production begins

3.2.3.3 Fines Storage Area 1

This area would drain to two sediment basins (B and C, see **Figure 13**) each taking approximately half the catchment. They would be designed for the 5-day 95th percentile rainfall depth and so would have a conceptual volume of 1,650m^3, 310m^3 of which would be for temporary soil storage. The basins would be constructed before land clearing commences. Trapped sediment would be periodically removed and processed.

3.2.3.4 Fines Storage Area 2 and Soil and Mulch Stockpile Area

Together, these two areas lie within the footprint of the extraction area. Runoff from both areas would report to Sediment Basin A which would be designed for the 5-day, 95th percentile rainfall depth and so would have a conceptual volume of 6,000 m^3, 800m^3 of which would be for temporary soil storage. The basin would be constructed before land clearing commences within the fines storage area 2 and soil and mulch stockpile area.

Sediment Basin A would be a wet-type basin and so trapped water would be managed as described in Section 3.2.2.2. Trapped sediment would be periodically removed and processed.

To limit the catchment to Sediment Basin A (and, therefore limit its size), upslope clean water diversion drains would be constructed; refer to **Figure 14**.

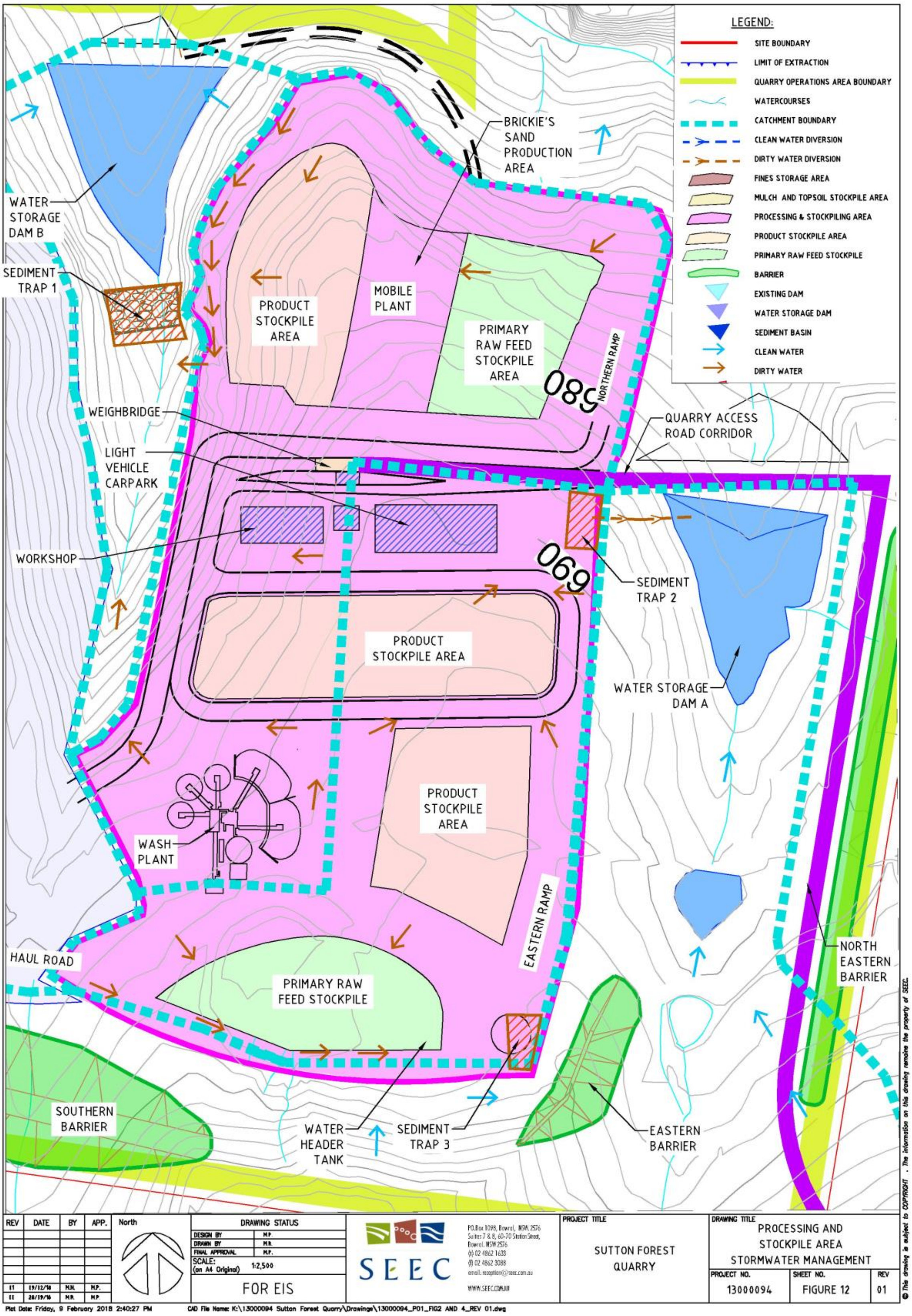

Figure 12 – Water Management in Vicinity of Processing and Stockpiling Area

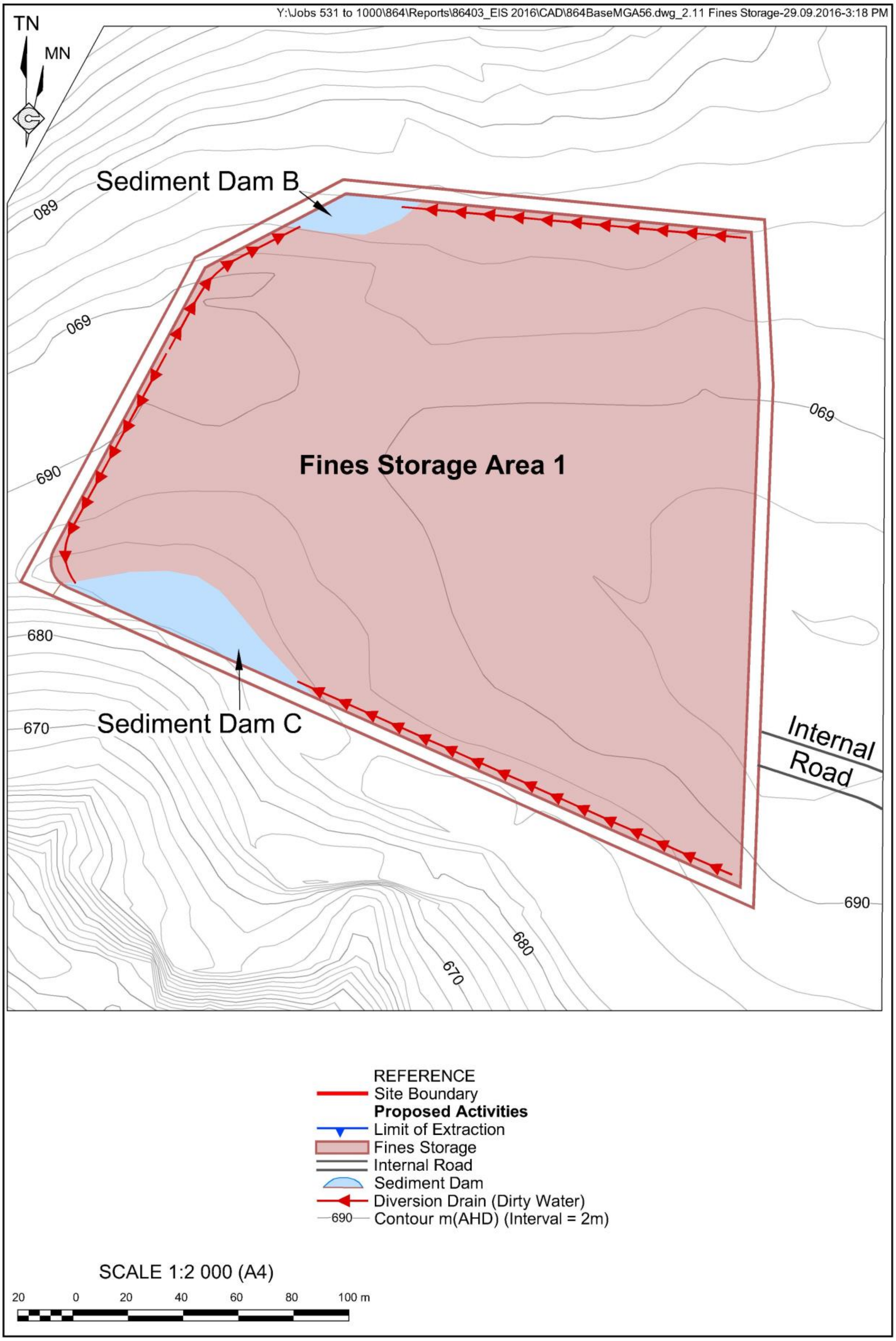

Figure 13 – Water Management, Fines Storage Area 1

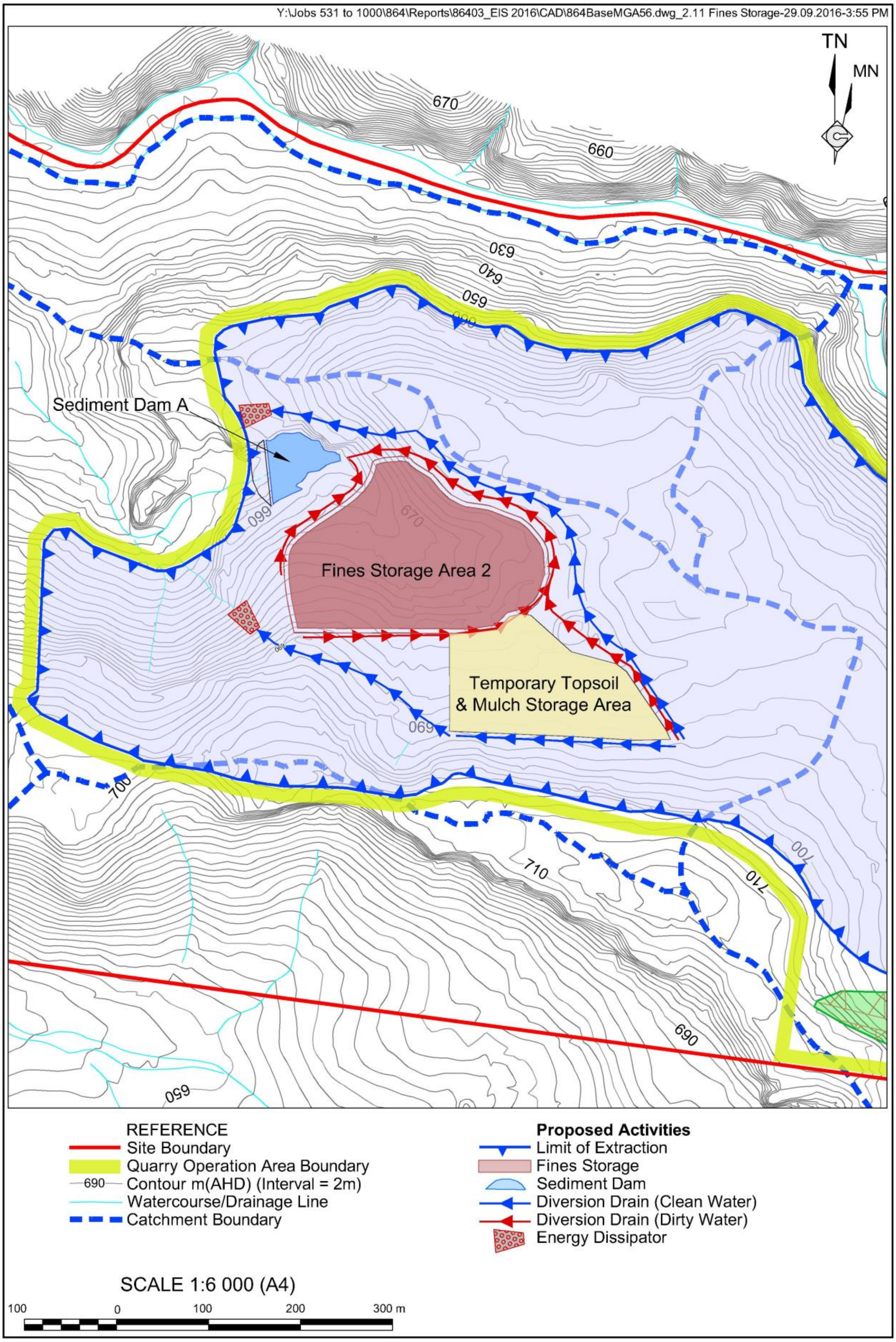

Figure 14 - Water Management, Fines Storage Area 2 and Stockpile Area

3.2.3.5 Barriers

During land clearing and construction of the barriers, surface runoff would be directed to the small existing dam just upstream of Water Storage Dam A (**Figure 12**). The dam may overflow as water would drain to the much larger water storage dam just downstream.

3.2.3.6 Quarry Access Road

The quarry access road would be approximately 1.4km in length and constructed with an average disturbance width of 10m, giving a total potential disturbance footprint of approximately 1.4ha. The anticipated construction period is eight months.

Best management erosion and sediment control management practices for road construction as described in Landcom (2004) and DECC (2008b) would be required during its construction.

Appropriately-sized Type C sediment basins, designed to treat the 2-year ARI design rainfall event would be installed along the alignment of the quarry access road. These basins would temporarily detain sediment-laden runoff and allow for natural settlement or filtration of sediment. All sediment basins would have a spillway designed for the 100-year ARI design rainfall event.

Each of the sediment basins would require regular maintenance to remove trapped sediment.

Prompt rehabilitation of temporarily disturbed areas and adequate drain/channel lining would be adopted to reduce the risk of erosion. A Water Management Plan prepared by a suitably-qualified person would be prepared before construction commences to provide details of all sediment basins and related drainage controls. Regular monitoring would be required during the construction phase, along with appropriate maintenance of all erosion and sediment controls.

3.2.4 Sediment Control – Operational Phase

3.2.4.1 Extraction Area

During Stage 1 of extraction, the land surface of the extraction area would drain towards Long Swamp Creek. Therefore, during this period it would be necessary to include appropriate sediment controls to manage sediment-laden runoff. One or more Type C sediment basins designed to treat flows up to the 2-year ARI design rainfall event would be used. The positioning of these controls would depend on surface contours and the progression of the excavation.

The sediment basin(s) would have stable spillways designed for the 100-year ARI design rainfall event. Stable flow paths would be provided to Long Swamp Creek.

Beyond Stage 1, the extraction area would become internally-draining and so would become a non-discharge area. Allowance would be made in the floor of the extraction area to contain stormwater runoff which would be allowed to percolate to groundwater or would evaporate.

3.2.4.2 Processing and Stockpiling Area

During the operational phase, the processing and stockpiling area would continue to drain to the water storage dams via sediment traps which would minimise excess sediment build-up in the water storage dams (**Figure 12**). Sediment would be regularly removed from the traps and from the dams (when they are dry) and processed in the wash plant. The water storage dams would have a combined volume of approximately 13.8ML (Section 5.1) and water would be used for processing and dust suppression.

The processing plant would incorporate a thickener and a series of filter presses to maximise the amount of water able to be recycled and, as such, the net make-up water demand for processing at full production would be 40kL/day (Section 5.3).

3.2.4.3 Quarry Access Road

The quarry access road would drain to vegetated table drains (swales) which would provide some treatment to runoff, particularly reducing the sediment load. Further treatment would be provided in a series of water quality basins which would be converted from the sediment basins installed during the construction phase (Section 3.2.3). However, each sediment basin would:

- be lined with clay to provide a permanent storage volume;
- have a trickle flow outlet designed to restrict peak flows to pre-development rates; and
- have a spillway designed for the 100-year ARI design rainfall event.

3.2.5 Erosion Control – Establishment and Operation Phase

During the Proposal's establishment and operation, erosion control would be undertaken in accordance with Landcom (2004). This means achieving appropriate levels of protective ground cover (measured as "C-Factor"[9]) within defined time scales (**Table 6**).

Table 6 – Required C-Factors and Timing for Achieving Them

Lands	Maximum C-Factor	Remarks
Waterways and other areas subjected to concentrated flow post construction	0.05	Applies after ten working days from the completion of formation and before they are allowed to carry concentrated flow. A C-Factor of 0.05 equals 70% ground cover.
Soil Stockpiles	0.1	Applies after ten working days from the completion of formation. A C-Factor of 0.1 equals 60% ground cover.
All lands including waterways and stockpiles during construction	0.1	Applies after twenty working days of inactivity even though works might continue later. A C-Factor of 0.1 equals 60% ground cover.
All lands post completion	0.05	Applies after 60 working days from the completion of formation. A C-Factor of 0.05 equals 70% ground cover.

[9] C-Factor is a measure of ground cover. It varies from 1 for bare soil to 0.005 for ~100% ground cover.

Where necessary, clean water would be diverted away from exposed areas such as batters, hardstands and stockpiling area.

3.2.6 Fuels and Oils

Diesel fuel required for earthmoving equipment would be contained in a dual-skin, self-bunded fuel tank. Minor oils and lubricants would be kept in small quantities (<20 L), undercover, on a sealed surface and on spill trays sufficient to capture 120% the volume of the largest container plus a volume equal to the displacement of neighbouring containers.

Suitable spill kits would be kept on site and staff members would be trained in their use. Used spill kit materials would be disposed in the on-site garbage collection and replaced immediately.

3.2.7 On-site Wastewater Management

Ablution facilities would be included within the site amenities. The maximum occupancy at the site is 22 staff, with up to 30 truck drivers per day also visiting (**Table 7**).

A design wastewater load of approximately 50L/person/day is suggested for site employees if toilets, basins, showers and kitchenette are supplied (NSW Health, 2001). This equates to a total daily load of about 1,100L. In addition, an allowance for each truck driver of 10L/day (300L/day) is suggested. Therefore, the design load would be 1,500 L/day at maximum occupancy and production. This wastewater load is approximately equivalent to a typical large home and so may be managed with systems suitable for domestic applications.

Wastewater would be treated to a secondary standard in an Aerated Wastewater Treatment System and disposed into subsurface absorption trenches or beds. The subsurface application areas would be located at least 40m from a drainage depression or similar (e.g. a stormwater drain), at least 40m from a dam and at least 100m from any watercourse that has identifiable bed and banks (SCA, 2012b).

Table 7 – Workforce Numbers

Position/Function	**No. Employed**	
	700 00tpa	**860 000tpa**
Direct Quarry Employment		
Quarry Manager	1	1
Administration	2	2
Weighbridge Officer	2	3
Sales	2	2
Wash Plant Operators	2	2
Mobile Equipment Operators	7	9
Mechanic/Fitter	2	3
Sub-total	**18**	**22**
Indirect Product Transport Contractors		
Truck Drivers	22	30
Total	**40**	**52**
Source: Sutton Forest Quarries Pty Ltd		

3.2.8 Neutral or Beneficial Effect (NorBE)

The Site lies within Sydney's drinking water catchment and so the requirements of State Environment Planning Policy (SEPP) Sydney's Drinking Water Catchment 2011 apply. The aim of the SEPP is to maintain the health of Sydney's drinking water. It is administered by Water NSW, formerly the Sydney Catchment Authority (SCA).

In order to address water quality, a series of Current Recommended Practices (CRPs) and performance standards have been endorsed by Water NSW. The CRPs and standards provide best practice solutions to manage the impact on water quality of a range of land uses including construction activities, extraction industries, road building and on-site wastewater. If all the relevant CRPs are adopted and successfully implemented then it can be assumed there would be a neutral or beneficial effect (NorBE) on water quality.

For this surface water assessment, the following CRPs have been referenced and would be implemented:

- Volumes 1, 2a, 2c and 2e of OEH's series *Managing Urban Stormwater* for all earthmoving activities (construction, extraction, stockpiling, rehabilitation) (Landcom, 2004) (DECC, 2008a, 2008b and 2008c).
- ARRB (2002). *Environmental practices for rural sealed and unsealed roads.* ARRB Group Pty Ltd, Vermont South, Victoria.
- SCA (2012a) for Onsite Wastewater Management.

4. GROUNDWATER – SURFACE WATER INTERACTION

4.1 EARLY QUARRY STAGES

The progressive removal of vegetation from the extraction area would result in the progressive cessation of evapotranspiration. As evapotranspiration accounts for approximately 80% of the prevailing losses in the natural water balance, this would represent a significant change to the recharge regime of the extraction area when compared to the present condition. Rainfall that would otherwise have evapotranspired would now be either:

- evaporated (if it were to remain at the surface long enough); or
- infiltrated through the subsurface into groundwater.

Given the highly permeable nature of the soils and the underlying sandstone, the latter is most likely to account for the loss of incident rainfall following development of the extraction area. Any rainfall infiltrated at the extraction area would most likely drain to groundwater via fissures and joints in the sandstone bedrock.

However, any sediment mobilised at the surface would be retained in the soil and rock matrix as water infiltrates and, as a result, the infiltrated water is unlikely to have a detrimental effect on groundwater aquifer quality. Similarly, given the overall size of the aquifer, the additional infiltration would represent a minimal change when considered at a catchment scale.

4.2 FINAL VOID

During the latter stages of the Proposal, and post quarrying, the groundwater modelling (Larry Cook Consulting Pty Ltd, 2016) predicts:

- The extraction area would receive average modelled inflow of 0.14 ML/day. This would be supplied by a maximum reduction of 0.052 ML/day in baseflow of 51ML/yr Long Swamp Creek. The reduction for Long Swamp and Long Swamp Creek would be 3.6 % of the modelled baseflow.

The actual dimensions of the sump containing this water may fluctuate significantly, according to the intensity of rainfall events, seasonal rainfall volume, evaporation and the geometry of the extraction floor.

Loss of surface water from the void at this stage would be by evaporation.

5. SURFACE WATER BALANCE

5.1 HARVESTABLE RIGHT

The harvestable right multiplier for the Site is 0.085ML/ha. The Site boundary encloses 174.4ha[10] and so the total harvestable right would be 14.8ML. There is only one 1ML dam within the site boundary and so there is 13.8ML available as a harvestable right. This would be divided equally between Water Storage Dams A and B.

5.2 SURFACE WATER LICENCES

There is no proposal to harvest surface water over and above the harvestable right. Therefore:

- no licence would be required under the Water Management Act 2000; and
- there would be no potential impacts to any existing surface water license holders downstream.

5.3 WATER DEMAND

Water would be required to wash the sand to be produced as concrete sand and to provide dust suppression. Much of the water used to wash the sand would be recovered, but it is anticipated that losses would occur due to evaporation and loss by product-moisture. A proportion of the water harvested would also be lost as a result of evaporation from water storages on the Site. The Applicant has calculated that approximately 95L of water would be lost per tonne of washed sand from the cycle through evaporation and retention in the sand products and fines by-product.

Dust suppression would be required in the extraction area and around the processing and stockpiling area. PEL (2018) estimates the demand for dust suppression would be 12ML/year. Water demand for dust suppression purposes would vary seasonally throughout the year depending on the ratio of potential evaporation to rainfall. **Table 8** shows the mean annual make-up water requirements for the wash plant.

Table 8 – Plant Make-Up Water Requirements at Various Production Levels

Annual Washed Sand Production (tpa)	Mean Annual Make-up Water Requirements (ML)
390 000	36
630 000	59
780 000	73

Table 9 shows the total annual water demand for the Proposal, based on the make-up water requirements in **Table 8** and the maximum annual use for dust suppression.

[10] The area contained within the site boundary

Table 9 – Total Annual Water Requirements at Various Production Levels

Annual Washed Sand Production (tpa)	Annual Make-up Water Requirements (ML)
390 000	48
630 000	71
780 000	85

5.4 SURFACE WATER SOURCES

5.4.1 Proposed Water Storage Dams

Two new water storage dams would be constructed on first order watercourses near the processing and stockpiling area (**Figure 12**). They would each have a capacity of 6.9 ML and they would both be protected from sedimentation by upstream sediment traps.

For the purpose of modelling stormwater runoff volumes, the processing and stockpiling area is assumed to be effectively 75% impervious.

5.4.2 Existing Dams

The existing dam has a capacity of about 1ML and would remain just upstream of Water Storage Dam A (**Figure 12**). It would be permissible to draw water from it but, for the purpose of modelling, it is assumed that this would not be the case.

5.5 SURFACE WATER SUPPLY

Modelling of the surface water balance was conducted using eWater's MUSIC software. Two rainfall data sets were used, one being 5-years of pluviograph data in 6-minute time steps as described in Section 2.3.6 and the other being more than 50 years of daily rainfall data as described in Section 2.3.2.

For the purposes of estimating water security, more emphasis has been placed on the daily rainfall data, as it covers a considerably longer time period; the difference between the two models was minimal (<1%). The results of the daily water balance modelling for the three production scenarios in **Table 9** are given in **Table 10**.

Table 10 – Water Demand Confidence

Annual Washed Sand Production (tpa)	Annual Make-up Water Requirements[11] (ML)	Demand Supplied (ML)	Shortfall (ML)	% Demand Met
390 000	48	40	8	83
630 000	71	48	23	68
780 000	85	52	33	61

Table 10 gives the mean results over the period modelled. Data was then exported from MUSIC to determine the percentage of demand met at full production for various annual rainfall runoff percentiles (**Table 11**).

Table 11 – Water Demand Confidences at Full Production

Annual Rainfall Runoff Percentile %	Water Supplied ML/year	% Demand Met
5	77.6	91
10	71.6	84
50	48.3	57
90	33.2	39
95	32.2	38
100	26.2	31

[11] includes dust suppression

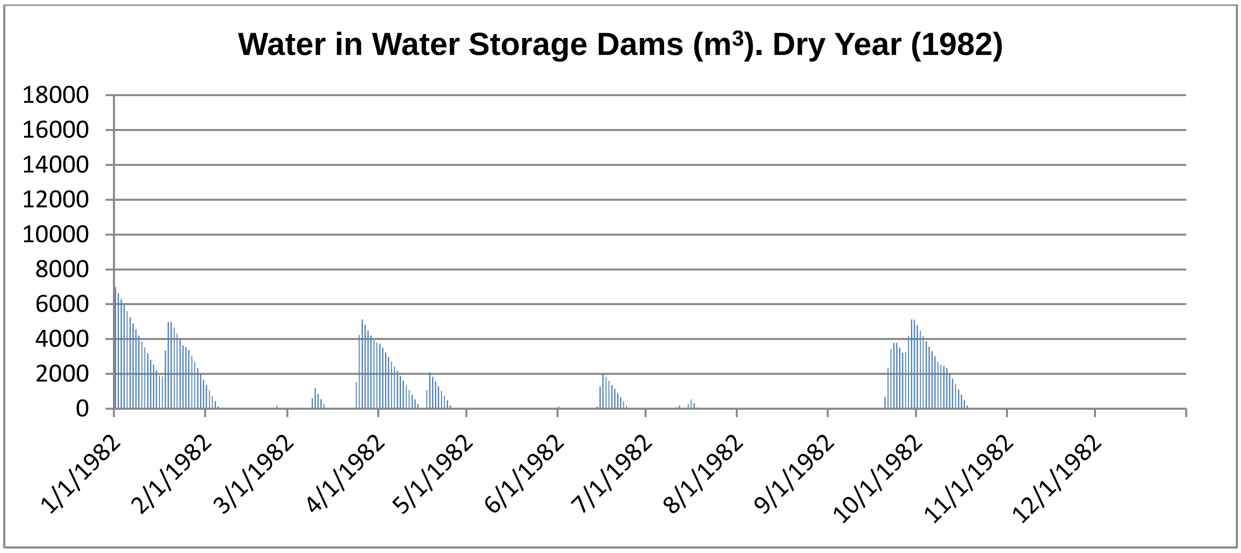

Figure 15 – Combined Water Storage Dams Storage (Dry Year, 1982)

5.6 SURFACE WATER BALANCE SUMMARY

Figure 16 provides a summary of the surface water balance. It shows the catchments, storages, mean annual demands at peak production and mean annual outflows.

5.7 BACK UP SUPPLY

For those periods when surface water is not available, supplementary water would be sourced from additional sources, either through acquisition of allocations or commercial agreement.

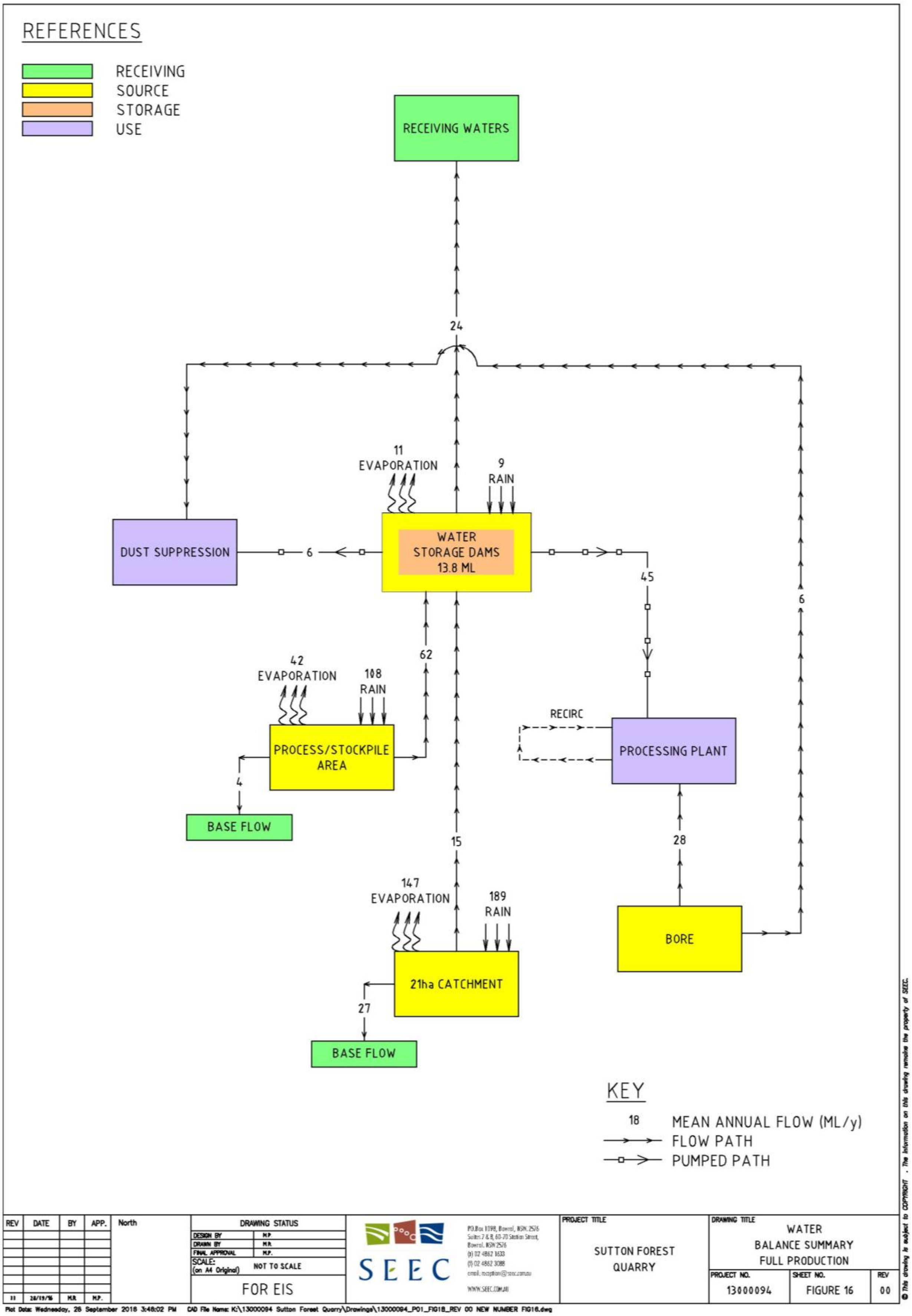

Figure 16 – Water Balance Summary Full Production

6. SURFACE WATER QUALITY MONITORING

6.1 INTRODUCTION

This section provides a description of the Surface Water Quality Monitoring Program that would be undertaken throughout the life of the Proposal. There would be three parts to this Program:

- Site Rainfall Recording;
- Infrastructure Monitoring; and
- Surface Water Quality Testing.

All three aspects of the Monitoring Program apply during both the establishment and the operational stages of the Proposal.

6.2 SITE RAINFALL RECORDING

Daily rainfall would be automatically monitored at the on-site meteorological station using a calibrated rainfall gauge. The data would be documented and used to assess and justify overflows from sediment basin(s) (i.e. those discharges that occur because the rainfall event exceeds the design capacity of those structures).

6.3 INFRASTRUCTURE MONITORING

6.3.1 Objectives

The objectives of the Surface Water Infrastructure Monitoring Program would include regular inspections of the various surface water management structures and measures across the Site to ensure that:

- surface water structures and their inlets/outlets are stable, free from scour and are performing satisfactorily;
- potential problems are addressed before they arise (e.g. identifying potential failure points or the onset of tunnel or gully erosion);
- clean (off-site) and dirty (on-site) water are effectively separated; and
- spill containment measures are adequate and are being followed.

6.3.2 Inspections

At least once per month and after significant (>25m/day) rainfall, the site’s Environmental Officer (or their representative) would undertake a walk-over of the Site and complete an assessment of all surface water structures using an appropriate Inspection Checklist. Where issues are identified, they would be noted on the checklist for action within a reasonable timeframe given the inherent risk. Non-compliances would be reported to the Manager and the relevant government agencies notified, if required. The completed checklists would be kept on file and a summary of the results of the inspections would form part of the Annual Review.

6.4 SURFACE WATER QUALITY MONITORING

6.4.1 Site Discharge Points

6.4.1.1 Site Establishment and Construction Stage

During the site establishment and construction stage, all sediment basins and the water storage dams would be considered site discharge points. Controlled discharges (i.e. stormwater managed up to the design rainfall events) from these structures would be required to meet the water quality standards in **Table 12.** Uncontrolled discharges (i.e. stormwater released during rainfall events that exceed the design capacity of the sediment retention structures) would occur periodically and, during such events, the concentration of suspended solids detailed in **Table 12** may be exceeded.

Table 12 – Water Quality Targets for Sediment Basins (Controlled Discharges) and Water Storage Dams

Pollutant/parameter	Target Value
pH	6.5-8.5[12]
Total Suspended Solids	<50mg/L[13]
Salinity (EC)	<350µS/cm[12]
Oil and Grease	None Visible[13]

6.4.1.2 Operational Stages

During the operational stages of the Proposal, Sediment Basins A, B and C and the two water storage dams would be considered site discharge points. Controlled discharges (i.e. stormwater managed up to the design rainfall events) from these structures would be permissible but must meet the water quality targets in **Table 12**. These water quality targets, and their associated design rainfall events, would be described in a Site-specific Environmental Protection License (EPL).

Uncontrolled discharges (i.e. stormwater released during rainfall events that exceed the design capacity of the sediment retention structures) would occur periodically and, during such events, the concentration of suspended solids detailed in **Table 12** may be exceeded.

The water quality basins adjacent to the quarry access road would not be considered site discharge points and, therefore, regular monitoring and water quality testing would not be required. All areas disturbed during construction of the Quarry access road would be effectively stabilised either as sealed pavement or as vegetated or rock-lined batters, drains or verges.

6.4.1.3 Monitoring Frequencies

Water quality in the water storage dams would be monitored quarterly and within 24 hours of the commencement of any overflow from them. The sampling and testing parameters are given in **Table 12.**

[12] Consistent with ANZECC (2000)
[13] Consistent with Landcom (2004)

Water quality in Sediment Basins A, B and C would be measured before permitting a controlled discharge. The sampling and testing parameters are given in **Table 12.** Uncontrolled discharges caused by exceedance of the design rainfall event would not be monitored, apart from noting their data and time.

6.4.2 Water Quality Monitoring in Long Swamp Creek

6.4.2.1 Objectives

Water quality monitoring in Long Swamp Creek would initially be undertaken on a monthly basis and following any rainfall events of more than 68 mm in five days[14]. This would be done to achieve the following objectives:

- To establish the baseline (existing) water quality.
- To monitor water quality during and after quarry operations.
- To minimise the potential for impacts on aquatic ecosystems downstream of the Site.

6.4.2.2 Water Quality Sampling Locations

Figure 4 illustrates the three established water quality testing locations on Long Swamp Creek.

6.4.2.3 Sampling Frequencies

Water quality in Long Swamp Creek would be tested monthly for the first two years, after which the frequency would be adjusted in consultation with the EPA and DPI - Water.

6.4.3 Sampling Procedures

The following procedures would be implemented during all surface water monitoring operations:

- Field monitoring equipment would be used and calibrated according to the manufacturer's instructions. Calibration dates would be recorded.
- Laboratory samples would be collected by appropriately trained personnel. They would be taken:
  - from a shallow depth using an extendable sampling arm if required;
  - using bottles provided by the testing laboratory. Bottles would be correctly labelled, preserved and transported to the laboratory within the appropriate Technical Holding Time under a chain of custody protocol to the laboratory.
- It would be permissible to compile a site-specific correlation between total suspended solids and turbidity so that turbidity can be measured on site to immediately estimate the concentration of total suspended solids.

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[14] i.e. more than the 95th percentile 5-day rainfall depth.

The results of all water quality testing would be recorded in the Quarry's environmental database for submission in the *Annual Review*. They would be analysed as detailed in Section 0.

6.4.4 Water Quality Triggers

The receiving water (Long Swamp Creek) is classified as a NSW, slightly disturbed, upland stream. The stress investigation-triggers provided in ANZECC (2000) are given in **Table 13**. There are no proposals to use chemicals and there are no known concentrations of heavy metals in the proposed product. As a result, it is considered unnecessary to test for such toxicants.

Table 13 – Stream Water Quality Investigation Triggers

Pollutant/parameter	Trigger Value (ANZECC, 2000)
pH	<6.5 or >8.5
Total suspended solids	50mg/L*
Turbidity	25NTU
Salinity (EC)	350µS/cm
Total Phosphorous	20µg/L
Total Nitrogen	250µg/L
Total Oxides of Nitrogen	15µg/L
Ammonia	12µg/L
Dissolved Oxygen	>90%<110%

6.5 SURFACE WATER RESPONSE PLANS

6.5.1 Stream Water

Initially, a trigger for further investigation would be deemed to occur if the median concentration of a test varied from the values given in **Table 13** (Note: if only one sample is taken then the result of that test would be used). However, once a background data set of at least 18 samples (two years) was collected, that data could be used in consultation with EPA and DPI – Water to develop a site-specific suite of trigger values for the Site.

Following receipt of all water monitoring results for WQL2, WQL3 or WQL4, the Applicant would, within three business days, review that data against the relevant trigger values**.** In the event that one or more trigger value was exceeded (and the exceedance can be attributed to the Applicant's activities within the Site) the Applicant would immediately:

- arrange for further check sampling to be undertaken to confirm the initial monitoring result (the resultant median value would be adopted); and
- contact the relevant government agencies (Environment Protection Authority, DPI - Water, the Division of Resources and Energy, Sydney Catchment Authority) and advise them of the preliminary results and timeframes for completion of further check sampling and reporting.

Should the check sampling indicate that water quality in Long Swamp Creek remains outside the relevant trigger values, the Applicant would immediately contact the above agencies to advise them of the result of the check sampling and determine, in consultation with them, appropriate management actions. These would include but not be limited to:

- immediate implementation of appropriate management measures; and
- engagement of suitably qualified and experienced aquatic and environmental experts in consultation with the above agencies to further investigate and report on the exceedance(s), provide advice in relation to the significance of the exceedance(s) and recommended amelioration measures to be implemented (if they are necessary). This would include comment on the comparison between upstream and downstream results. It is noted that Swamp Creek is a biologically productive, nutrient rich and probably reductive environment. Therefore, total nitrogen, pH and dissolved oxygen could be influenced by swamp conditions.

In the event that the first-round of stream water quality results indicated a significant (>50%) variation of the relevant trigger values, the Applicant would implement the above measures immediately and not wait for check sampling to confirm the initial result.

A copy of any resulting expert's report would be provided to relevant government agencies.

6.5.2 Sediment Dams A, B and C

Trapped water in Sediment Basins A, B and C would be tested for the parameters in **Table 12** prior to a conditional discharge. If one or more of the parameters is exceeded then the release would be postponed until the target(s) can be met. That might require, for instance, additional flocculation or pH adjustment.

6.5.3 Water Storage Dams

Following receipt of water monitoring results of samples collected during the overflow from the water storage dams, the Applicant would, within three business days, review that data against the relevant trigger values in **Table 12.** In the event that one or more trigger values was exceeded, The Applicant would immediately undertake an investigation as to why and, if the cause is identified, immediately take measures to mitigate the problem.

Should there be a continuation of non-compliance, the Applicant would engage a suitably qualified and experienced environmental expert in consultation with the above agencies to further investigate and report on the exceedance(s), provide advice in relation to the significance of the exceedance(s) and recommended amelioration measures to be implemented.

6.5.4 Post-Quarry Closure

The Surface Water Monitoring Program, as amended, would continue until the Applicant and all relevant Government Agencies agree that final rehabilitation has been achieved.

7. POST-QUARRY CONDITIONS

Figure 17 presents the proposed indicative final landform of the Quarry and illustrates the proposed final topography. The key features of the final landform would be as follows.

1. The northern and eastern sections of the extraction area would be comparatively flat with a gentle slope to the north and west. There would be no surface runoff toward Long Swamp Creek.
2. The southern and southwestern extraction faces would be retained with up to 1.5m of overburden/oversize material on each bench providing a substrate for native vegetation.
3. The lowest area topographically within the extraction area would be in the north where a water storage would be created. The water storage would allow percolation and evaporation but would have no direct overflow to receiving waters.
4. The southern side of the processing and stockpiling area would be re-profiled with the material recovered from the eastern and north-eastern barriers. A final slope approaching 1:3 (V:H) would be created in this area. Topsoil and vegetation would be replaced. The sediment traps would remain in place (and be appropriately managed) until at least 70 percent ground cover is achieved.
5. The footprints of the visual barriers would be returned to ongoing agricultural use.
6. The footprint of the fines storage areas would be re-shaped following the removal of all fines to re-instate a landform comparable with the pre-quarry landform. Topsoil and vegetation would be replaced. The sediment dams would remain in place (and be appropriately managed) until at least 70 percent ground cover is achieved.
7. The quarry access road would be retained to provide long-term access for subsequent land use. The water quality basins would remain to provide treatment to stormwater runoff from it.

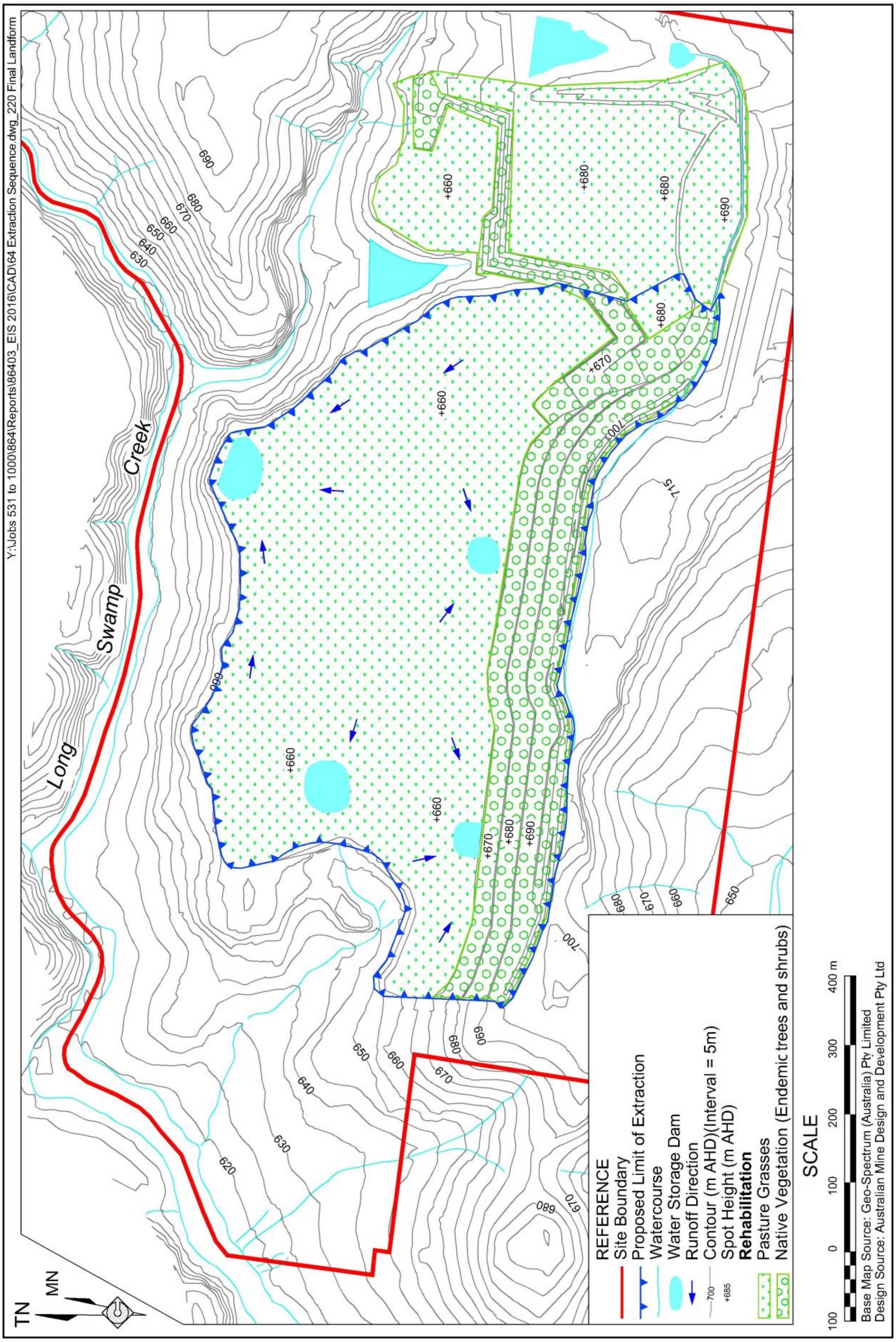

Figure 17 – Post Quarry Landforms

8. SUMMARY OF COMMITMENTS

8.1 DURING SITE ESTABLISHMENT

During establishment of the Quarry, there would be significant disturbance to the natural landform. Soil would be exposed to erosion and there could be subsequent sediment movement/loss. During this period, soil and water would be managed to the requirements of Landcom (2004), DECC (2008a) and DECC (2008b).

A Water Management Plan incorporating Erosion and Sediment Control Plan would be prepared prior to any disturbance to describe the soil and water management requirements for the Proposal. Individual construction stages might be the subject of one or more progressive ESCP, each of which would detail soil and water management for that specific part of the Proposal.

8.2 OPERATIONAL STAGE

During the operational stage, surface water would be managed to the requirements of Sections 3, 4 and 5 of this document. Surface water derived from the individual components of the Quarry would be directed to the various water management structures as shown in **Figures 12** to **14.**

Potential contaminants such as mechanical fluids and oils would be stored under cover and on spill trays. Diesel fuel would be stored in one or more dual-skinned, self-bunded, tanks.

Onsite wastewater would be managed in an appropriately designed onsite wastewater management system.

A program would be implemented to:

- ensure the satisfactory operation of all water management structures;
- monitor water quality in the Long Swamp Creek;
- monitor the Site's daily rainfall;
- implement response plans as necessary;
- document water management practices including any required responses in the Site's Annual Review; and
- consistently provide information to the relevant Government Agencies.

8.3 POST REHABILITATION

Post rehabilitation, entrained rainfall would either evaporate or become groundwater re-charge. The former processing and stockpiling area and fines storage areas would all be rehabilitated to yield final landforms similar to those pre-existing quarry development. The Quarry access road and the water storage dams would remain.

During rehabilitation works, soil would be exposed to erosion and there could be subsequent sediment movement/loss. During this period, soil and water would be managed to the requirements of Landcom (2004) and DECC (2008). Individual rehabilitation stages would be the subject of a specific ESCP which would detail soil and water management for that specific part of the Site's rehabilitation.

9. REFERENCES

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10. APPENDICES

APPENDIX 1 – COVERAGE OF SURFACE WATER-RELATED AGENCY REQUIREMENTS

Page 1 of 4

Organisation	Paraphrased Requirement/Issue	Relevant Section(s)
DIRECTOR-GENERAL'S REQUIREMENTS		
SOIL AND WATER		
The EIS must address the following specific issues:		
Water Resources including – • detailed assessment of potential impacts on the quality and quantity of existing surface and Groundwater resources, including the impacts on: - existing user entitlements, affected licensed water users and basic landholder rights;		3.1 3.2 5
- regional water supply infrastructure.		EIS
• detailed site water balance, including a description of site water demands, water disposal methods (inclusive of volume and frequency of any water discharges), water supply infrastructure and water storage structures;		5
• identification of any licensing requirements or other approvals under the Water Act 1912 and/or Water Management Act 2000;		5.2
• demonstration that water for the construction and operation of the development can be obtained from an appropriately authorised and reliable supply in accordance with the operating rules of any relevant Water Sharing Plan (WSP) or water source embargo; and		5
• a detailed description of the proposed water management system, water monitoring program and other measures to mitigate surface and groundwater impacts;		6
ISSUES RAISED BY OTHER GOVERNMENT AGENCIES		
WATER – GENERAL		
EPA (21/01/14)	Demonstrate that environmental outcomes for the project ensure: • There is no pollution of waters (including surface and groundwater) except in accordance with licence requirements • Wastewater is captured on the site and directed to reticulated sewer where available or collected, treated and beneficially reused, where this is safe and practicable to do so • There is consistency with any relevant Statement of Joint Intent established by Healthy Rivers Commission; and • It contributes to the protection of achievement over time of River Flow Objectives and Water Quality Objectives.	3.2 6 3.2.7
	Describe the nature and the degree of any likely impacts that the proposed project may have on the receiving environment and clearly outline the proposed mitigation, monitoring and management measures	3 6
	Determine the requirements that apply to the local catchment and clearly identify any sensitive areas.	2.2.2
	Address the potential for any diesel or chemical spills and any necessary bunding and/or spill management measures	3.2.6

Coverage of Surface Water-related Agency Requirements (Cont'd)

Page 2 of 4

Organisation	Paraphrased Requirement/Issue	Relevant Section(s)
ISSUES RAISED BY OTHER GOVERNMENT AGENCIES (Cont'd)		
EPA (21/01/14) (Cont'd)	Document the soil and water management controls that will be implemented during the project to minimise any potential impacts on water quality	3.2.3 3.2.4
	Address impacts and mitigation measures associated with water supply at the site.	5
DPI - NOW (06/02/14)	The EIS should demonstrate: • An adequate and secure water supply for the proposal. Confirmation that water supplies for the quarry operation, associated activities incorporated into product and any other losses, are sourced from an appropriately authorised and reliable supply.	5
	• Identify through a water balance the: - site water demands in terms of volume and timing; - water sources (surface and groundwater); - water disposal methods; - water storage structures including Maximum Harvestable Right Dam Capacity; - annual volume of groundwater to be intercepted - annual volume of groundwater to be extracted/used for quarry purposes and any other losses - annual volume of surface water intercepted by the quarry operations and volumes extracted for any purpose; - volume and purpose of all dams/water storages on the contiguous land holding of the proponent; and - any water reticulation infrastructure that supplies water to and within the site.	5
	• Existing and proposed water licensing requirements in accordance with the Water Management Act 2000 and Water Act 2012 (as applicable). This is to demonstrate that existing licences (include licence numbers) and licensed uses are appropriate, and to identify where additional licences are proposed.	5.2
	• Existing and proposed water licensing requirements in accordance with the Water Management Act 2000 and Water Act 2012 (as applicable). This is to demonstrate that existing licences (include licence numbers) and licensed uses are appropriate, and to identify where additional licences are proposed.	5.2
	• Ensure licensing is commensurate with the anticipated volume of groundwater take and surface water take prior to this take occurring.	5.2

Coverage of Surface Water-related Agency Requirements (Cont'd)

Page 3 of 4

Organisation	Paraphrased Requirement/Issue	Relevant Section(s)
ISSUES RAISED BY OTHER GOVERNMENT AGENCIES (Cont'd)		
DPI - NOW (06/02/14) (Cont'd)	• An impact assessment on adjacent licensed water users (surface and groundwater), basic landholder rights, and groundwater-dependent ecosystems, notably Long Swamp and Stingray Swamp as well as Long Swamp Creek and adequate provision of buffer requirements.	5.2
	• Assess watercourses to be crossed and describe appropriate techniques and mitigating measures to minimise impacts on those watercourses.	Design
	• Design and construct any crossings/works in/within 40m of watercourses are to be in accordance with NSW Office of Water Guidelines for Controlled Activities on Waterfront Land (July 2012).	Design
	• Adequate mitigating and monitoring requirements to address surface water and groundwater impacts.	6
	Water Sharing Plans Demonstrate that the proposed project is consistent with the relevant access and trading rules within the following: • Water Sharing Plan for the Greater Metropolitan Region Unregulated River Water Sources 2011 • Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011.	5.2
	• Detail the extent to which the proposed project is consistent with relevant legislation, policies and guidelines, and justify any inconsistencies.	3.2 6
SURFACE WATER		
NOW (06/02/14)	Consider the impact of the Proposal on the watercourse and associated riparian vegetation within the site and provide the following; • Identify the sources of surface water	5
	• Details of stream order (using the Strahler System)	2.2
	• Details of any proposed surface water extraction, including quantity, purpose, location of existing pumps, dams, diversions, cuttings and levees	5
	• Details of available surface water licenses that could be purchased to account for any proposed extractions.	5.2
	• Detailed description of any proposed development or diversion works including all construction, clearing, draining, excavation and filling.	3

Coverage of Surface Water-related Agency Requirements (Cont'd)

Organisation	Paraphrased Requirement/Issue	Relevant Section(s)
ISSUES RAISED BY OTHER GOVERNMENT AGENCIES (Cont'd)		
SURFACE WATER (Cont'd)		
NOW (06/02/14) (Cont'd)	• An assessment of the impacts of proposed methods of excavation, construction and material placement on the watercourse and associated vegetation	NA
	• A detailed description of all potential water related environmental impacts of any proposed development in terms of riparian vegetation, sediment movement, water quality and hydrologic regime.	3 4 5
	• A description of the design features and measures to be incorporated into any proposed development to guard against anything more than minimal long term actual and potential environmental disturbances, particularly in respect of maintaining the natural hydrologic regime and sediment movement patterns and the identification of riparian buffers (see note below)	3.2
	• Details of impact on water quality and remedial measures proposed to address more than minimal adverse effects	3.2
	For existing or proposed Water Management Structures/Dams provide information on the following: • Date of construction (for existing structure/s) • Details of legal status/ approval for existing structure/s • Details of any proposal to change the purpose of the existing structure/s • Details if any remedial work is required to maintain the integrity of the existing structure/s • Clarification if the structure/s is on a watercourse • Details of the purpose, location and design specification for the structure/s • Size and storage capacity of structures/s • Calculation of the Maximum Harvestable Right Dam Capacity (MHRDC) for the site • Details if the structures/s is affected by flood flows. • Details of any proposal for shared use, rights and entitlement of the structure/s • Details if the proposed development has the potential to bisect the structure/s	2.2.5 5.4 5.1
	Identify existing basic landholder rights users and potential impacts to these rights associated with the proposal.	5.2
	Assess the provision of a sustainable water supply and include Water Management Plans detailing how sustainable water supply can be sourced and implemented	5

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