Appendix J – Surface and Groundwater Assessment

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January 2023

Surface and Groundwater Assessment for Razorback Quarry, Running Stream

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Revision Table

Date	Version	Author	Reviewed	Approved
22/11/2022	D0	TO	GVT/SS	TO
20/01/2023	F0	TO	GVT/SS	TO

Running Stream Quarry Surface and Groundwater Assessment	
Name of Quarry	Razorback Quarry
Applicant	Plantation Pine Products Pty Ltd
Contact Details of the Applicant	Shaun Smith Principal Environmental Planner Space Urban Pty Ltd
Author of Report	Tara O'Brien
Signature	[redacted]
Date	20/01/2023
Approved by	Shaun Smith
Signature	

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1 Introduction

1.1 CONTEXT

This Surface and Groundwater Management Assessment (WMA) has been prepared to address the Secretary's Environmental Assessment Requirements (SEARs) issued to Plantation Pine Products Australia Pty Ltd (PPPA) on the 2nd of March 2021 in response to a development proposal for a gravel and sand quarry located at Running Stream, NSW. This plan will be incorporated into the Environmental Impact Statement to be submitted to the Mid-Western Regional Council, as the consent authority.

1.2 BACKGROUND

The proposed gravel quarry (Site) is accessed via a private gravel road within Lot 2 DP 569979, Parish of Warrangunia, County Roxburgh, located at 39 Razorback Road Running Stream, approximately 60 kilometres north of Lithgow, off the Castlereagh Highway. *Figure One* shows the site location regionally and locally.

The quarry development, if the proposal is granted, would consist of the extraction of in situ conglomerate and weathered sandstone resources for the construction and decorative gravel industries.

1.3 CONSULTATION

The proponent sought the Planning Secretary's Environmental Assessment Requirements (SEARs) which were prepared in consultation with relevant government agencies. Relevant requirements from the SEARs are reproduced below.

Table 1. SEARs Requirements for the Environmental Impact for Water

SEARs Requirements	Where Addressed in this Report
The EIS must address the following specific issues: Water- including	
• a detailed site water balance and an assessment of any volumetric water licensing requirements, 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;	Section 8
• identification of any licensing requirements or other approvals under the Water Act 1912 and/or Water Management Act 2000;	Section 3.3, Section 3.4.6, Section 4.5.5, Section 5
• 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);	Section 3.3, Section 3.4.6, Section 4.5.5, Section 5, Section 8
• a description of the measures proposed to ensure the development can operate in accordance with the requirements of any relevant WSP or water source embargo;	Section 3.3, Section 3.4.6, Section 4.5.5, Section 5, Section 8
• a detailed consideration of the need to maintain an adequate buffer between all excavations and the highest predicted groundwater table;	Section 7
• an assessment of activities that could cause erosion or sedimentation issues, and the proposed measures to prevent or control these impacts;	Section 5.3, Section 5.5
• an assessment of any likely flooding impacts of the development;	Section 4.5.3, Section 6.4

SEARs Requirements	Where Addressed in this Report
• an assessment of potential impacts on the quality and quantity of existing surface and ground water resources, including a detailed assessment of proposed water discharge quantities and quality against receiving water quality and flow objectives; and	Section 5, Section 8, Section 8
• a detailed description of the proposed water management system (including sewage), water monitoring program and other measures to mitigate surface and groundwater impacts;	Section 5

Table 2. SEARs Requirements from Biodiversity, Conservation and Science Directorate

SEARs Requirements	Where Addressed in this Report
2. Environmental Impacts of the Proposal The proponent must consider, assess, quantify and report on the likely environmental impacts of the proposal if applicable, particularly: • Biodiversity • National Park estate: land reserved or acquired under the National Parks and Wildlife Act 1974 • Flooding, floodplain issues and coastal erosion • Cumulative impacts	Section 4.5.3, Section 6.4, Section 6.5
5. Water • The EIS must map features relevant to water, including: o Rivers, streams, estuaries (as described in s4.2 of the Biodiversity Assessment Method). o Wetlands (as described in s4.2 of the Biodiversity Assessment Method). o Groundwater. o Groundwater dependent ecosystems.	Figure Two, Figure Three, Figure Four, Figure Ten, Figure Eleven. Table 15
• The EIS must describe background conditions for any water resource likely to be affected by the proposal, including: o Existing surface and groundwater. o Hydrology	Section 4

SEARs Requirements	Where Addressed in this Report
o Water Quality Objectives (as endorsed by the NSW Government) including groundwater as appropriate that represent the community's uses and values for the receiving waters. Indicators and trigger values/criteria for the identified environmental values in accordance with the ANZECC (2000) Guidelines for Fresh and Marine Water Quality and / or local objectives, criteria or targets endorsed by the NSW Government	Section 9
o Risk-based Framework for Considering Waterway Health Outcomes in Strategic Land-use Planning Decisions (OEH/EPA, 2017).	Section 9
• The EIS must assess the impacts of the proposal on water quality, including: o The nature and degree of impact on receiving waters for both surface and groundwater, demonstrating how the proposal protects the Water Quality Objectives where they are currently being achieved, and contributes towards achievement of the Water Quality Objectives over time where they are currently not being achieved. This should include an assessment of the mitigating effects of proposed stormwater and wastewater management during and after construction.	Section 6, Section 7 Section 9, Section 10
o Identification of proposed monitoring of water quality.	Section 10
o Consistency with any relevant certified Coastal Management Program (or Coastal Zone Management Plan).	Not Applicable
• The EIS must assess the impact of the proposal on hydrology, including: o Water balance including quantity, quality and source.	Section 8
o Effects upon rivers, wetlands, estuaries, marine waters and floodplain areas.	Section 6, Section 7
o Effects upon water-dependent fauna and flora including groundwater dependent ecosystems.	Section 7
o Impacts to natural processes and functions within rivers, wetlands, estuaries and floodplains that affect river system and landscape health such as nutrient flow, aquatic connectivity and access to habitat for spawning and refuge (e.g. river benches).	Table 15 (Not Applicable)
o Changes to environmental water availability, both regulated / licensed and unregulated / rules-based sources of such water.	Section 6, Section 7

SEARs Requirements	Where Addressed in this Report
6. Flooding • The EIS must map the following features relevant to flooding as described in the Floodplain Development Manual 2005 (NSW Government 2005) including:	Not Applicable Site is not subject to flooding nor lies on flood prone land.
o Flood prone land (ie land susceptible to the probable maximum flood event).	Not Applicable
o Flood planning area, the area below the flood planning level.	Not Applicable
o Hydraulic categorisation (floodway and flood storage areas).	Not Applicable
o Flood hazard	Not Applicable
• The EIS must describe flood assessment and modelling undertaken in determining the design flood levels for events, including a minimum of the 10% Annual Exceedance Probability (AEP), 1% AEP flood levels and the probable maximum flood, or an equivalent extreme event.	Not Applicable
• The EIS must model the effect of the proposal (including fill) on the current flood behaviour for a range of design events as identified above, and the 0.5% AEP and 0.2% AEP year flood events as proxies for assessing sensitivity to an increase in rainfall intensity of flood producing rainfall events due to climate change.	Not Applicable
• All site drainage, stormwater quality devices and erosion / sedimentation control measures should be identified in the EIS and the onsite treatment of stormwater and effluent runoff and predicted stormwater discharge quality from the proposal should be detailed.	Section 6, Section 7
• Modelling in the EIS must consider and document: o Existing council flood studies in the area and examine consistency to the flood behaviour documented in these studies.	Not Applicable
o The impact on existing flood behaviour for a full range of flood events including up to the probable maximum flood (PMF), or an equivalent extreme flood.	Not Applicable
o Impacts of the proposal on flood behaviour resulting in detrimental changes in potential flood affection of other developments or land. This may include redirection of flow, flow velocities, flood levels, hazard categories and hydraulic categories.	Not Applicable
o Impacts of earthworks and stockpiles within the flood prone land up to the PMF level. The assessment should be based on understanding of cumulative flood impacts of construction and operational phases.	Not Applicable

SEARs Requirements	Where Addressed in this Report
o Relevant provisions of the NSW Floodplain Development Manual 2005.	Not Applicable
• The EIS must assess the impacts on the proposal on flood behaviour, including:	Not Applicable
o Whether there will be detrimental increases in the potential flood affectation of other properties, assets and infrastructure.	Not Applicable
o Consistency with Council floodplain risk management plans.	Not Applicable
o Consistency with any Rural Floodplain Management Plans.	Not Applicable
o Compatibility with the flood hazard of the land.	Not Applicable
o Compatibility with the hydraulic functions of flow conveyance in floodways and storage in flood storage areas of the land.	Not Applicable
o Whether there will be adverse effect to beneficial inundation of the floodplain environment, on, adjacent to or downstream of the site.	Not Applicable
o Whether there will be a direct or indirect increase in erosion, siltation, destruction of riparian vegetation or a reduction in the stability of river banks or watercourses.	Not Applicable
o Appropriate mitigation measures to offset potential flood risk arising from the proposal. Any proposed mitigation work should be modelled and assessed on the overall catchment basis in order to ensure it fits its purpose and meets the criteria of the Council where it is located, and to ensure it has no adverse impact to surrounding areas.	Not Applicable
o Any impacts the proposal may have upon existing community emergency management arrangements for flooding. These matters are to be discussed with the NSW SES and Council.	Not Applicable
o Whether the proposal incorporates specific measures to manage risk to life from flood. These matters are to be discussed with the NSW SES and Council.	Not Applicable
o Emergency management, evacuation and access, and contingency measures for the proposal during both construction and operational phases considering the full range of flood risk (based upon the probable maximum flood or an equivalent extreme flood event). These matters are to be discussed with and have the support of Council and the NSW SES.	Not Applicable
o Any impacts the proposal may have on the social and economic costs to the community as a consequence of flooding.	Not Applicable

Table 3. Department of Primary Industries Requirements for the Environmental Impact for Water

SEARs Requirements	Where Addressed in this Report
Suitability and secure water supply	
• Detail the estimated water demand and water availability and the source of water and any sanitisation methods proposed.	Section 5, Section 8
• Outline any impacts to water use for agriculture and measures to mitigate against these impacts.	Section 6

Table 4. Environmental Protection Authority Requirements for the Environmental Impact for Water

SEARs Requirements	Where Addressed in this Report
Water The EIS should	
1. Describe water usage for the proposal including the position of any intakes and discharges, volumes, water quality and frequency of all water discharges.	Section 5, Section 6, Section 8
2. Describing existing surface water and groundwater quality. An assessment needs to be undertaken for any water resource likely to be affected by the proposal.	Section 4
3. State the Water Quality Objectives for the receiving waters relevant to the proposal. These refer to the community's agreed environmental values and human uses endorsed by the NSW Government as goals for ambient water. http://www.environment.nsw.gov.au/ieo/index.htm. Where groundwater may be impacted the assessment should identify appropriate groundwater environmental values.	Section 9
4. State the indicators and associated trigger values or criteria for the identified environmental values. This information should be sources from the ANZECC (2000) Guidelines for Fresh and Marine Water Quality. http://www.environment.gov.au/water/quality/publications/australian-and-new-zealand-guidelines-fresh-marine-water-quality-volume-1.	Section 9, Section 10.1
5. State any locally specific objectives, criteria or targets which have been endorsed by the NSW Government.	Section 9
6. Provide a water balance for the development including water requirements (quantity, quality and sources(s) and proposed storm and wastewater disposal, including type, volumes, proposed treatment and management methods and re-use options.	Section 8, Section 5

SEARs Requirements	Where Addressed in this Report
7. Demonstrate that all practical options to avoid discharge have been implemented and environmental impact minimised where discharge is necessary.	Section 5, Section 6, Section 7, Section 9, Section 10
8. Describe the nature and degree of impact that any proposed discharges will have on the receiving environment.	Section 6, Section 7
9. Assess impacts against the relevant ambient water quality outcomes. Demonstrate how the proposal will be designed and operated to: • Protect the Water Quality Objectives for receiving waters where they are currently achieved; • Contribute towards achievement of the Water Quality Objectives over time where they are not currently being achieved.	Section 5, Section 6, Section 7, Section 9, Section 10
10. Where a discharge is proposed that includes a mixing zone, the proposal should demonstrate how wastewater discharged to waterways will ensure the ANZECC (2000) water quality criteria for relevant chemical and non-chemical parameters are met at the edge of the initial mixing zone of the discharge, that any impacts in the initial mixing zones area demonstrated to be reversible.	Not Applicable No mixing zone present due to ephemeral nature of drainage line and creeks.
11. Describe how predicted impacts will be monitored and assessed over time.	Section 10
12. Assess potential impacts on groundwater dependant ecosystems.	Section 7
13. Detail the erosion and sediment controls to be implemented to minimise erosion and sediment mobilisations at the site which have been designed in accordance with the publication Managing Urban Stormwater: Soils and Construction (Landcom 2004). The EIS should show the location of each measure to be implemented for the construction and operation phases of project. The measures to be considered include: • Sediment traps • Diversion banks • Sediment fences • Bunds (earth, hay, mulch) • Geofabric lines • Other control measures as appropriate.	Section 5 Figure Six, Figure Seven, Figure Eight

Table 5. Natural Resources Access Regulator Requirements for the Environmental Impact for Water

SEARs Requirements	Where Addressed in this Report
The Natural Resources Access Regulator (NRAR) has reviewed the supporting documentation accompanying the request for SEARs and recommends the Environmental Impact Statement (EIS) be required to include the following;	
• The identification of an adequate and secure water supply for the life of the project. This includes details of water sources that water will be taken from, and demonstration that appropriate licences and approvals are held or can be obtained under the Water Management Act 2000, or any relevant exemptions that apply under Schedule 4 of the Water Management (General) Regulation 2018.	Section 5 Section 3.3, Section 3.4
• A detailed and consolidated site water balance.	Section 8
• Assessment of impacts on surface and ground water sources (both quality and quantity), related infrastructure, adjacent licensed water users, basic landholder rights, watercourses, riparian land, and groundwater dependent ecosystems, and measures proposed to reduce and mitigate these impacts.	Section 6, Section 7, Section 3.3, Section 7.3
• Proposed surface and groundwater monitoring activities and methodologies.	Section 10
• Consideration of relevant legislation, policies and guidelines, including the NSW Aquifer Interference Policy (2012), the Guidelines for Controlled Activities on Waterfront Land (2018) and the relevant Water Sharing Plans (available at https://www.industry.nsw.gov.au/water).	Section 3
• Before commencing any proposed works on waterfront land, an application under the Water Management Act 2000 for controlled activity approval (CAA) must be submitted to Natural Resources Access Regulator. Works cannot commence until a CAA has been issued, unless an exemption applies under Schedule 4 of the *Water Management (General) Regulation 2018*, please refer to NRAR's Exemption Factsheet (available at https://www.industry.nsw.gov.au/__data/assets/pdf_file/0004/172093/Controlledactivity-approval-exemptions-fact-sheet.pdf)	Section 3.4.5

Plan of:	**Surface Water Assessment for Razorback Quarry, Running Stream - Site Location**	**Location:**	39 Razorback Road, Running Stream, NSW	**Source:**	Google Earth 25/10/2021, Google OpenStreet Map & NSW Clip & Ship Accessed October 2022 Zone MGA 55	**Plan By:**	JD
Figure:	**ONE**	**Council:**	Mid-Western Regional Council	**Survey:**	Not Applicable	**Project Manager:**	TO
Version/Date:	V0 22/11/2022	**Tenure:**	Not Applicable	**Projection:**	GDA2020/MGA Zone 55 EPSG:7855	**Office:**	Thornton
Our Ref:	12453_SU_RBQ_EIS_SWA_Q001_V2_F1	**Client:**	Space Urban Pty Ltd	**Contour Interval:**	Not Applicable		

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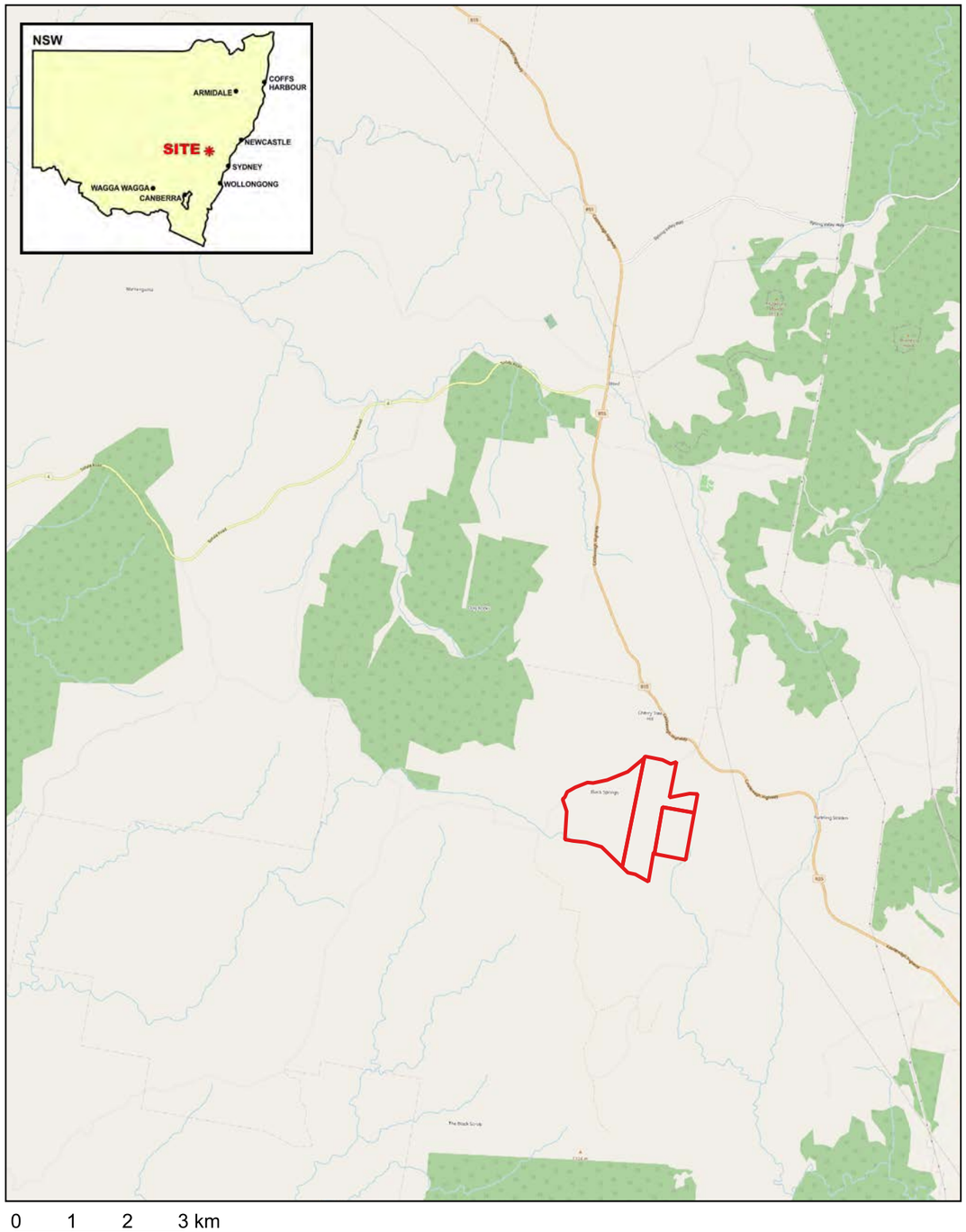

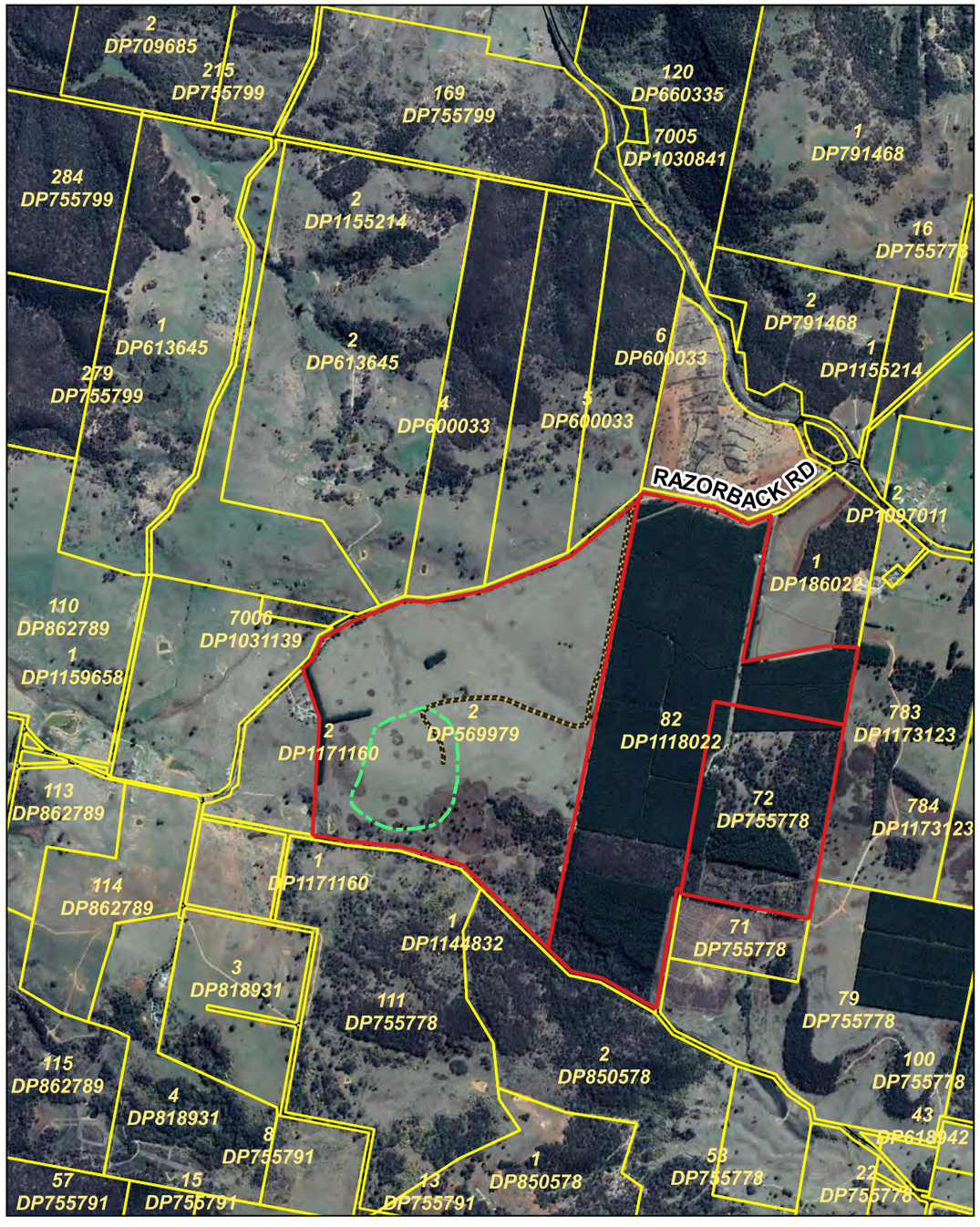

Plan of:	**Surface Water Assessment for Razorback Quarry, Running Stream - Site Layout**	**Location:**	39 Razorback Road, Running Stream, NSW	**Source:**	Google Earth 25/10/2021 & NSW Clip & Ship Accessed October 2022 Zone MGA 55	**Plan By:**	TO/JD
Figure:	**TWO**	**Council:**	Mid-Western Regional Council	**Survey:**	NSW Government Spatial Services, October 2012 Survey, Accessed Through Elvis & Clip & Ship October 2022	**Project Manager:**	TO
Version/ Date:	V2 21/11/2022	**Tenure:**	Not Applicable	**Projection:**	GDA2020/MGA Zone 55 EPSG:7855		
Our Ref:	12453_SU_RBQ_EIS_SWA_Q002_V2_F2	**Client:**	Space Urban Pty Ltd	**Contour Interval:**	1 Metre		

0 150 300 450 m

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This figure may be based on third party data which has not been verified by vgt and may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and vgt does not warrant its accuracy.

Legend

Site Features
- Property Boundary
- Lot Boundary (Cadastral)
- Road Corridor
- 1m Contour
- 5m Contour

Quarry Features
- Extraction Boundary
- Bund
- Office, Crib Room & Toilets
- Weighbridge
- Workshop Shed (20 x 12m)
- Haul Road
- Hardstand & Carpark

Water Management Features
- Existing Site Dam
- Creek/Main Drainage Line

2 Purpose and Objectives

2.1 PURPOSE OF THE ASSESSMENT

The purpose of this Assessment is to describe the proposed water management system for the Site and to clarify how potential water impacts generated by the development will be managed.

2.2 OBJECTIVES OF THE WATER MANAGEMENT SYSTEM

The principle objectives of the water management system are set out below:

- To minimise erosion and sedimentation from all active and rehabilitated areas, thereby minimising sediment ingress into surrounding surface waters;
- To ensure the segregation of 'dirty' water from 'clean' water and manage 'dirty' water appropriately such that any discharge from the Site meets the relevant water-quality limits, including limits contained in the relevant guidelines and any limits imposed by specific project approvals. 'Dirty' water is defined as surface runoff from disturbed catchments. 'Clean' water is defined as surface runoff from catchments that are undisturbed or rehabilitated catchments;
- To minimise the volume of water discharged from the Site but, should the discharge of water prove necessary, ensure sufficient settlement time is provided prior to discharge or employ other means such as flocculants to ensure the water meets the objectives identified in the point above;
- That appropriate licences and approvals are held or can be obtained under the Water Management Act 2000, or any relevant exemptions that apply under Schedule 4 of the Water Management (General) Regulation 2018;
- To ensure any water used in the processing of materials is contained within the closed system on the Site;
- To monitor the effectiveness of surface water and sediment controls and to ensure all relevant surface water quality criteria are met;
- To minimise the impact to any groundwater resources;
- To determine a water balance for the Site based on current and projected usage; and
- Develop a set of performance criteria and appropriate environmental management measures for the Site.

3 Legislative Requirements

3.1 ENVIRONMENTAL PLANNING AND ASSESSMENT ACT 1979 (EP&A ACT)

The proposal will be subject to the provisions of the EP&A Act. Additionally, the operations will need to be able to demonstrate compliance against any Conditions of Approval issued under the provisions of the EP&A Act.

3.2 PROTECTION OF THE ENVIRONMENT OPERATIONS ACT 1997 (POEO ACT)

At the proposed extraction rate of up to 200,000 tonnes of material per annum, the operations are a Scheduled Activity under the PoEO Act. As such, an Environmental Protection Licence (EPL) will be required.

3.3 WATER MANAGEMENT ACT 2000

3.3.1 Surface Water

The Site does not meet the definition of a mine under the Mining Act 1992, nor does it meet the definition of a 'mining activity' under the Under Section 60(I) of the Water Management Act 2000, as it is not extracting a mineral as defined in the Mining Act. The licencing is therefore administered by Water NSW, rather than the Natural Resources Access Regulator (NRAR).

Harvestable Rights relates to a landholder's right to capture a measured amount of annual rainfall on his/her property up to a point where they do not need a water access licence. Once a dam is measured at over harvestable rights, then then a Water Access Licence (WAL), for the amount above the measured Maximum Harvestable Right Dam Capacity (MHRDC), is required.

The use of the water contained in any proposed dam can be for any purpose if the volume held is under the Harvestable Rights. If the proposed dam exceeds the Harvestable Rights, and the water is to be used for an activity related to the primary activity (i.e. dust suppression or irrigation of rehabilitation), not only is a WAL required but a use approval is required. In any case, all new dams require a work approval from Water NSW prior to construction.

The Maximum Harvestable Right Dam Capacity has been calculated using the Water NSW online calculator tool and estimates that the MHRDC is 26.4ML, for the property described as 39 Razorback Road, Running Stream (330ha) (see *Appendix C*). The capacity of existing and proposed dams is discussed in Section 4.5.5 and is under the Harvestable Rights.

The site is located in the Water Sharing Plan for the Macquarie Bogan Unregulated and Alluvial Water Source- Turon Crudine River Water Source.

3.3.2 Groundwater

The Site is located within the NSW Murray Darling Basin Porous Rock Groundwater Source Management Area and there are no upper or middle aquifers identified on the site (Australian Government- Bureau of Meteorology, Australian Groundwater Report http://www.bom.gov.au/water/groundwater/explorer/map.shtml). The lower aquifer identified is classified as generally 'Sedimentary Rocks of the Sydney Basin'. The development is not expected to intercept the groundwater source at the mine due to the ridgeline setting and no licencing will be required for groundwater take.

A piezo was established in BH7, located centrally within the proposed quarry, where groundwater was encountered at approximately 1049m RL. This is some 6 metres below the proposed base of the quarry.

A stock bore is located to the north of the proposed quarry, adjacent to Razorback Road (80WA705933). The recorded final depth of this bore is 18.3m from the surface (1046m RL) at approximately 1028m RL.

3.4 GUIDELINES AND STANDARDS

3.4.1 Managing Urban Stormwater: Soils and Construction Vol1 and Vol 2E (Mines and Quarries)

Design details for stormwater and sediment control structures for mine and quarry sites are detailed in Volume 1 of the Managing Urban Stormwater: Soils and Construction Guidelines (the Blue Book). Additional measures are outlined within Managing Urban Stormwater, Soils and Construction, Volume 2E Mines and Quarries (DECC, 2008).

3.4.2 ANZECC (2000) Guidelines for Fresh and Marine Water Quality

Water Quality Objectives will be consistent with the indicators and trigger values/criteria, for the identified environmental values, outlined in the ANZECC (2000) Guidelines for Fresh and Marine Water Quality.

3.4.3 Risk Based Framework for Considering Water Health and Outcomes in Strategic Land-use Planning Decisions (OEH and EPA 2017)

The Framework allows decision-makers to determine management responses that meet waterway health outcomes which reflect the community's environmental values and uses of waterways – what the community believes is important for a healthy ecosystem, for public benefit, welfare, safety or health. It includes identification of water quality and flow objectives and a risk-based approach to mitigating the impacts of development.

3.4.4 NSW Aquifer Interference Policy (2012)

A licence to take groundwater will not be required as the extraction activities are unlikely to intercept any groundwater.

3.4.5 Guidelines for Controlled Activities on Waterfront Land (2018)

According to the online Waterfront Land e-tool (Department of Planning and Environment) no Controlled Activity Approval is required from Natural resources Access Regulator (NRAR).

Works are planned within 40 metres of a watercourse on the site include construction of sediment dams, overburden emplacement, access tracks and hardstand areas. These are located at the head of first order streams (Strahler stream order) that do not have a defined bed or bank, and do not have any watercourse features present. As such, the works are exempt from requiring a Controlled Activity Approval.

3.4.6 Water Sharing Plans

The site lies within the Macquarie Bogan Unregulated and Alluvial Water Source- Turon Crudine River Water Source. As the water proposed to be retained on the site is under the Harvestable Rights volume (see *Section 3.3.1* and *4.5.5*) no water access licence is required.

4 Existing Environment

4.1 LAND USE

The 327 hectare property is currently comprised of the following land uses:

- 68 % or 222 ha is planted out as pine plantation at various stages of progression, from recently planted tubestock to mature plantations through to areas that have been recently harvested and not yet re-planted;
- 19 % or 61 ha is other wooded or remnant vegetation, comprising both native and non-native species and includes the dwelling and yard area; and
- 13 % or 44 ha is comprised of access tracks and grassland areas through and surrounding the plantation area that are not planted as plantation. This includes a former pasture area around the area of the proposed quarry and the plantation firebreaks.

4.2 GEOLOGY AND SOILS

4.2.1 Regional Geology

The site is situated west and on the foothills of the Blue Mountains Range west of Sydney, NSW. The Contact between the Triassic and Permian aged suites is approximately 500 west of the site (Source Minview 3).

The Triassic Suite of rocks occurs approximately between 200 and 250 million years ago and the Permian 250 to 300 million years. The Triassic suite of rocks includes sandstone, claystone and conglomerates and was formed in large flood plains and the outcrop of these materials stretch across the Sydney Basin from around Moss Vale (south), Lithgow (west) and Morisset to the north. The underlying Permian which contain coal, sandstone and claystones, these outcrops reach as far south as South Durras, north to Nobbies Head at Newcastle and northwest to Ulan, near Mudgee. There is also overlying Cenozioc Basalts to the north, south and east of the site.

4.2.2 Site Geology

The local geology is the lower most portion of the Narrabeen Group, of which is most likely to be part of the Caley Formation which is Claystone, Shale and Quartz Lithic Sandstone (source Western Coalfield (Southern Part) 1:100,000 NSW Mines Department Geological Sheet. The surface exposures are sparse and small farm borrow pits show poorly consolidated conglomerates, with sandstone and clay matrix.

4.2.3 Soil Landscape

The soils on the Site are identified as Turonfels on the Environment NSW eSpade online data (https://www.environment.nsw.gov.au/eSpade2WebApp#). This soil landscape comprises undulating to rolling low hills with the dominant soils being red earths on mid to upper slopes, and yellow podzolic soils and yellow earths on lower slopes. Chocolate soils and skeletal sands and loams also occur on upper slopes.

Topsoils run to a depth of approximately 20cm are dull yellowish-brown loam, fine sandy with weak polyhedral peds; the pH is approximately 6.5. Subsoils show a sharp change to dull yellow orange fine sandy clay loam with weak structure; pH 6.0. They are moderately permeable, have a moderate to high erodibility and a moderate erosion hazard. Below the soil layers run sandstone, shale, conglomerate and siltstones, which are much lighter in colour.

Photoplate 1. Typical Soil Profile on the Site

4.3 TOPOGRAPHY

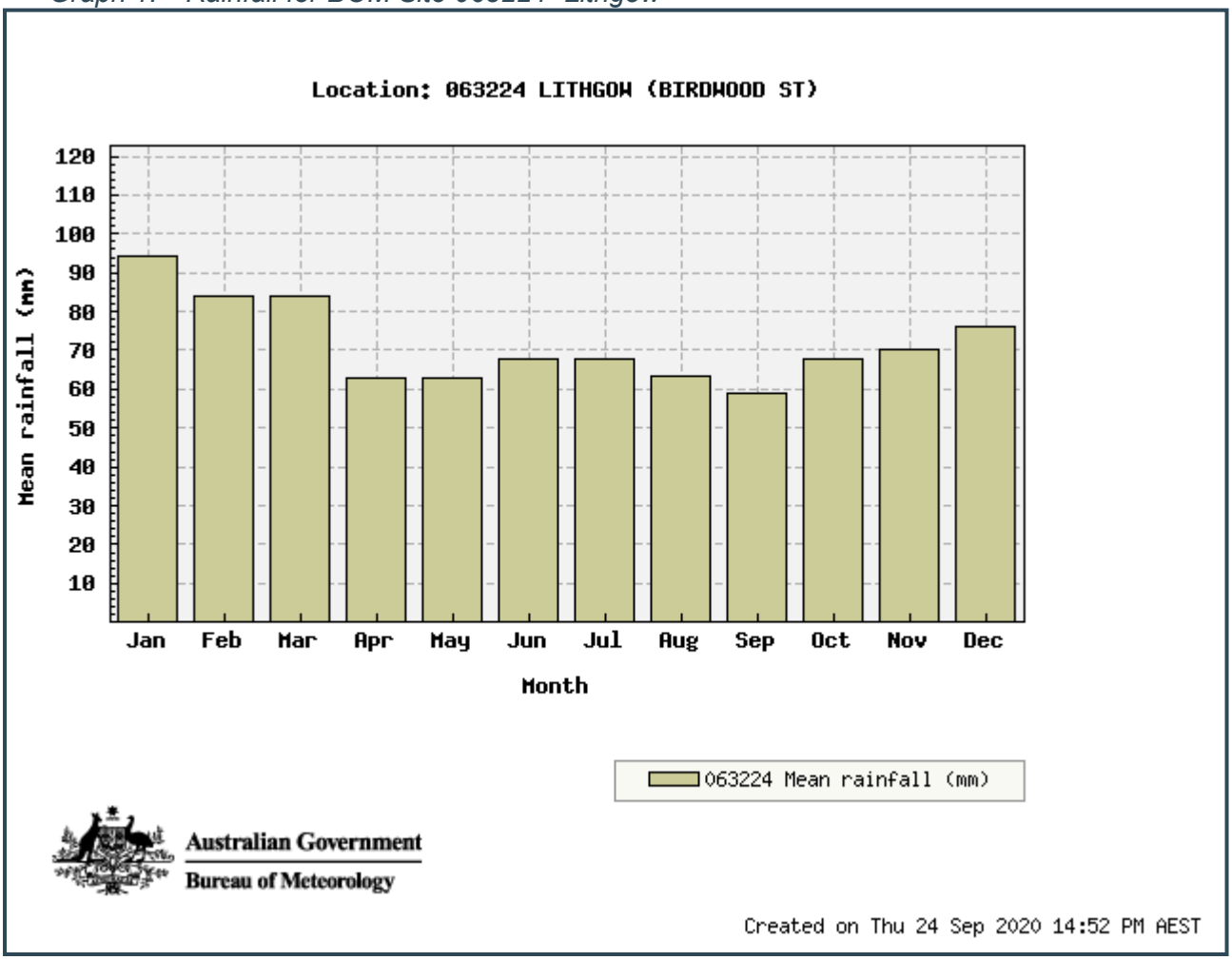
The Site is undulating to rolling low hills with elevations from 1,040–1,090 m. Slopes range from 6–20%, with slope lengths from 400–900 m. Drainage lines are few and variably spaced.

4.4 CLIMATE

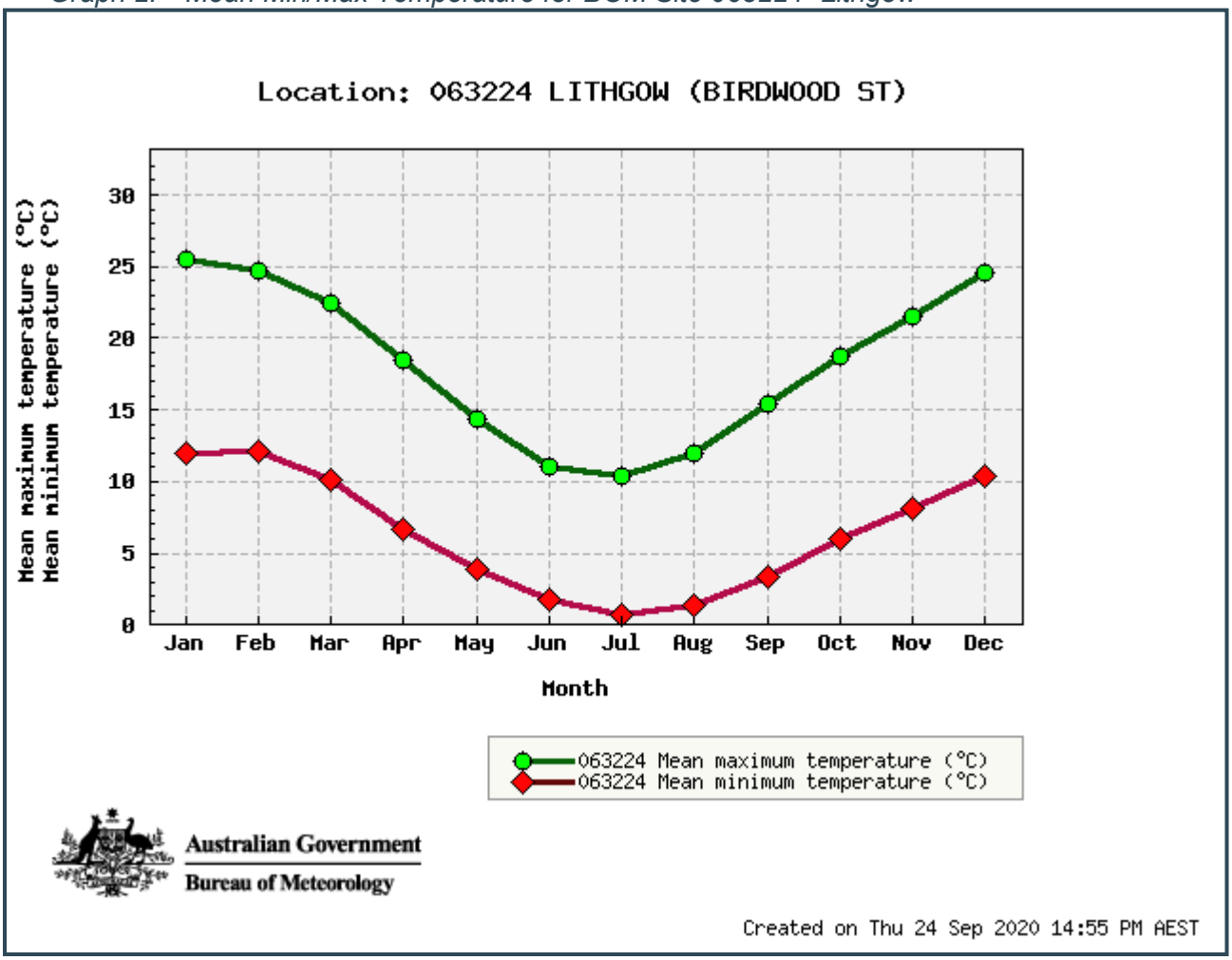
Climatic conditions at Running Stream are considered to be Cfb according to the Köppen-Geiger climate classification i.e. warm and temperate with significant rainfall.

Rainfall data sourced from the Bureau of Meteorology (Lithgow- site 063224) records an average annual rainfall of 862mm with higher rainfall experienced during the summer months. The mean annual average temperature is 18.5ºC and the mean annual minimum temperature is 6.4ºC. Morning winds are predominately westerly with a smaller component of north westerly and south westerly winds. Afternoon winds are similar in direction but stronger.

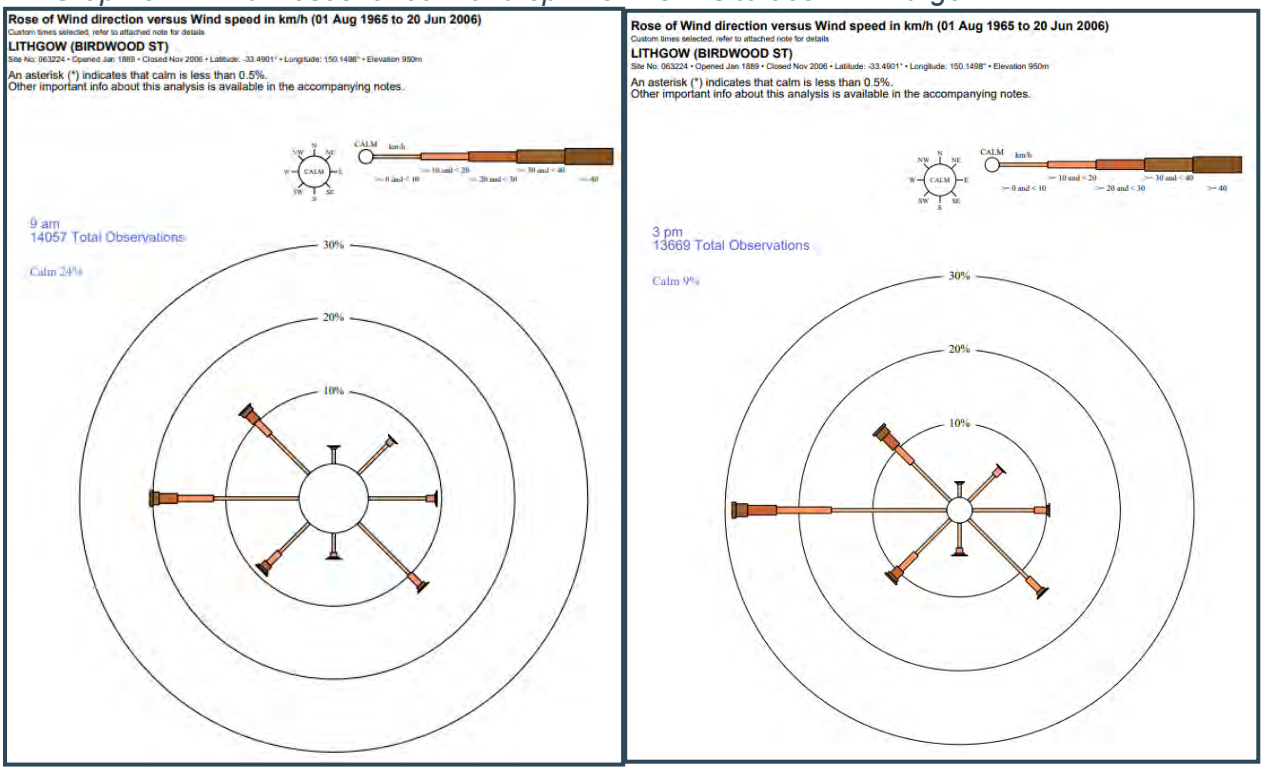
Graph 1. Rainfall for BOM Site 063224- Lithgow



Graph 2. Mean Min/Max Temperature for BOM Site 063224- Lithgow



Graph 3. Wind Roses for 9am and 3pm for BOM Site 063224- Lithgow



4.5 EXISTING HYDROLOGY

4.5.1 Regional Hydrology

The Site is located near the north-eastern watershed of the Macquarie River Catchment. Drainage lines on the site flow either into Two Mile Creek to the west of the Site or into Gibbons Creek to the southeast of the Site (see *Figure Three*).

Two Mile Creek flows in the Crudine River and thence the Turon River some 20 kilometres to the west of the Site eventually meeting the Macquarie River. Gibbons Creek enters Running Stream and thence Round Swamp Creek and eventually the Turon River in the south.

4.5.2 Site Drainage and Water Courses

There are no defined drainage lines within the footprint of the proposed quarry due to the elevated ridgeline (see Figure Four). Several drainage lines are located to the north of the quarry and flow into an unnamed creek to the north that joins Two Mile Creek. A drainage line in the south west of the quarry flows south to directly join Two Mile Creek and another in the south east joins Gibbons Creek lying further to the east. The ridgeline setting for the proposed quarry ensures that clean surface water can be directed around the disturbed area of the quarry and the dirty water catchment is restricted to the quarry footprint.

There is one farm dam located on the Site in the south west corner within the Two Mile Creek drainage line.

4.5.3 Flooding

The site is not identified as affected by flooding according to the NSW Government GIS planning services spatial data. It is located on an elevated setting and the risk of flooding is negligible.

Plan of:	**Surface Water Assessment for Razorback Quarry, Running Stream - Regional Drainage**	**Location:**	39 Razorback Road, Running Stream, NSW	**Source:**	Google Earth 25/10/2021 & NSW Clip & Ship Accessed October 2022 Zone MGA 55	**Plan By:**	TO/JD		
Figure:	**THREE**	**Council:**	Mid-Western Regional Council	**Survey:**	NSW Government Spatial Services, October 2012 Survey, Accessed Through Elvis & Clip & Ship October 2022	**Project Manager:**	TO		
Version/ Date:	V2 21/11/2022	**Tenure:**	Not Applicable	**Projection:**	GDA2020/MGA Zone 55 EPSG:7855				
Our Ref:	12453_SU_RBQ_EIS_SWA_Q003_V2_F3	**Client:**	Space Urban Pty Ltd	**Contour Interval:**	1 Metre				

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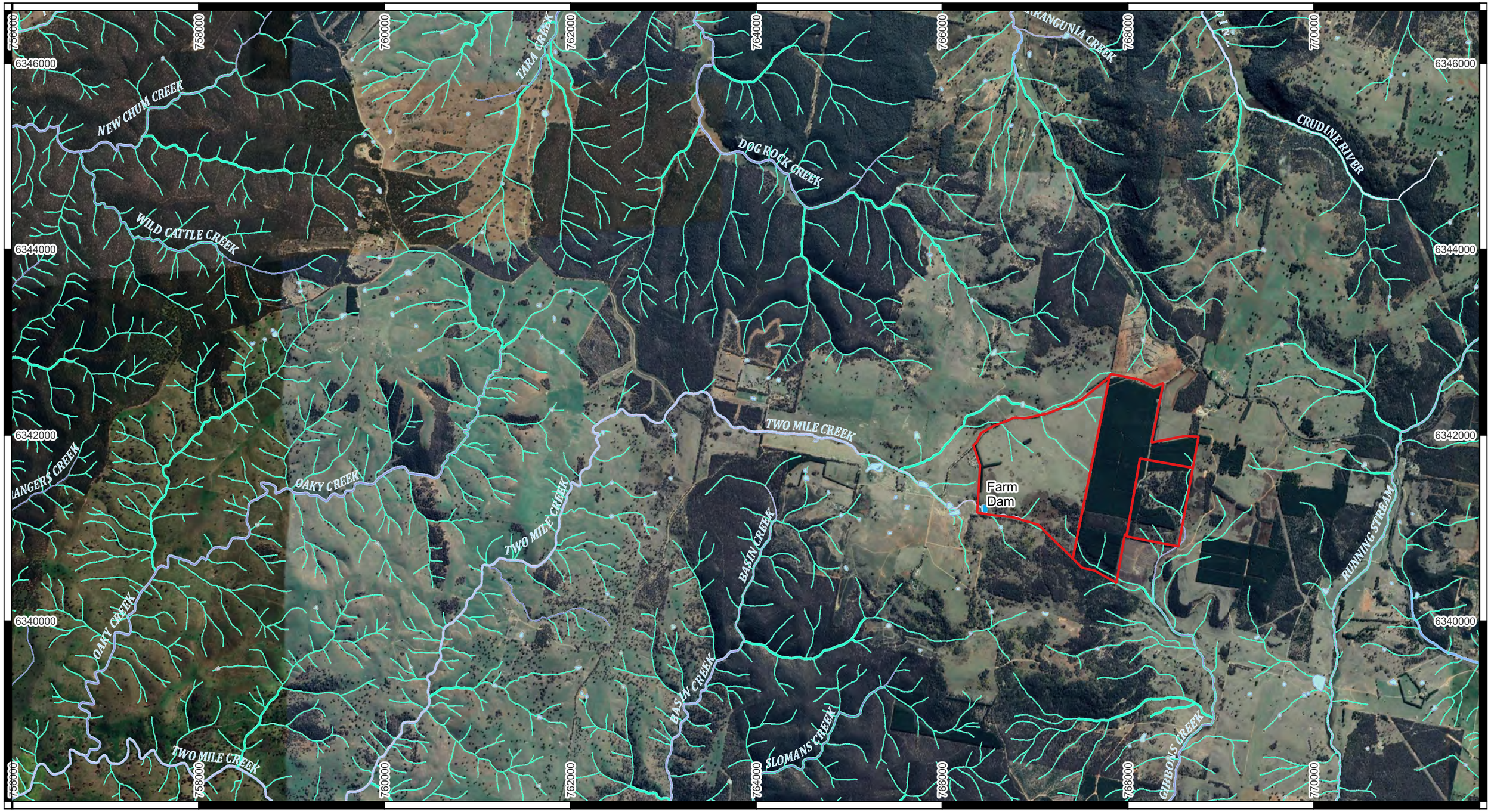

Legend

Site Features

- Property Boundary

Water Management Features

- Existing Site Dam
- Hydro Area
- Named Watercourse
- Creek/Watercourse

Plan of:	**Surface Water Assessment for Razorback Quarry, Running Stream - Site Drainage**	**Location:**	39 Razorback Road, Running Stream, NSW	**Source:**	Google Earth 25/10/2021 & NSW Clip & Ship Accessed October 2022 Zone MGA 55	**Plan By:**	TO/JD
Figure:	**FOUR**	**Council:**	Mid-Western Regional Council	**Survey:**	NSW Government Spatial Services, October 2012 Survey, Accessed Through Elvis & Clip & Ship October 2022	**Project Manager:**	TO
Version/ Date:	V2 21/11/2022	**Tenure:**	Not Applicable	**Projection:**	GDA2020/MGA Zone 55 EPSG:7855		
Our Ref:	12453_SU_RBQ_EIS_SWA_Q004_V2_F4	**Client:**	Space Urban Pty Ltd	**Contour Interval:**	1 Metre		

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Legend

Site Features

- Property Boundary
- Road Corridor
- 1m Contour
- 5m Contour

Water Management Features

- Existing Site Dam
- Creek/Main Drainage Line

4.5.4 Surface Water Quality

No surface water has been tested to date.

4.5.5 Water Quantity

The Maximum Harvestable Right Dam Capacity has been calculated using the Water NSW online calculator tool and estimates that the MHRDC is 26.4ML, for the property described as 39 Razorback Road, Running Stream (330ha). The site contains one farm dam that has an estimated area of 800 metres squared. If the depth is assumed to be approximately 2 metres, the maximum volume of water that could be held by the farm dam is 1,600 cubic metres, of 1.6ML. Estimated volumes of the proposed dams are shown in *Table 6.*

Table 6. Total Sediment Estimated Proposed Dam Volumes

Dam Identification/ Catchment	Dam Area (m^2)	Estimated Depth (m)	Estimated Volume (m^3)	Estimated Volume (ML)
Dam 1 (proposed)	2,185	2	4,370	4.37
Dam 2 (proposed)	3,733	2	7,470	7.47
Existing Dam	800	2	1,600	1.60
Total Volume			13,440	13.44

*Note: Area estimated from QGIS Google Earth satellite imagery.

Thus, the site could potentially retain up to 24.8ML before a WAL is required.

4.5.6 Groundwater

The nearest groundwater bore is located some 4 kilometres north of the site and does not provide any quality data on the Water NSW online data page (https://realtimedata.waternsw.com.au/water.stm). It is not located within the same watershed and is therefore not comparable to the Site.

A piezo was established in BH7, located centrally within the proposed quarry, where groundwater was encountered at approximately 1049m RL. This is some 6 metres below the proposed base of the quarry.

Due to the site being situated on the source of the local watershed, and the maximum depth of the proposed quarry (1,055m RL), it is unlikely that groundwater will be intercepted.

5 Proposed Water Management

All surface water captured within the disturbed area of the quarry will the diverted to an In-Pit Sump. Clean water diversion bunds will be constructed around the perimeter of the pit to prevent clean water from entering the disturbed area. Level spreaders will be installed at appropriate intervals to divert concentrated clean water flows down slope to sheet flows along the contours of the hill to the east of the proposed pit (see Figure Five to *Figure Eight*). Due to the quarry's elevated location, the dirty water catchment is restricted to the footprint of the quarry.

The proposed haul road will be maintained with gravel material to reduce sediment entrainment and provide an all-weather surface. Upslope clean water flows, encountering the haul road to the west of the site office, will be directed via drains to culverts under the road and thence energy dissipators to ensure there are no concentrated flows downslope. Clean water flows to the east of the office and hardstand will generally be diverted via a culvert to a clean water dam (Dam 1) to be constructed to the north of the office and weighbridge area. This dam will also receive surface water from the office and weighbridge area. Clean surface water captured upslope of the north eastern portion of the haul road meeting Razor Back Road will be directed via culverts under the road downslope. 'Whoa Boys' will be installed at appropriate intervals in the steeper sections of the haul road to reduce slope lengths and divert surface water off the road and reduce the potential for rilling.

Surface water collected within the in-pit sump will be treated, if required and pumped to a final polishing sediment dam to be constructed in the north of the pit (Dam 2), see *Figure Five*. From this dam water can be trickle released downstream and renter the unnamed water course to the north via a natural gully.

The volume of the sediment dams required to catch the design storm event within the fully developed disturbed area as recommended by the *Managing Urban Stormwater Soils and Construction –Volume 2E Mines and Quarries* guideline is shown in *Table 7* below.

Table 7. Sediment Dam Required Capacities

Dam Identification	Catchment Area (Ha)	Sediment Basin Storage (soil) Volume (m^3)	Sediment Basin Storage (water) volume (m^3)	Dam Volume Required for 90th percentile, 5-day rainfall event for a 5-day management period (m^3)
In Pit Sump (Stage One)	1.7	284	342	626
In Pit Sump (Stage Two)	7.57	1,263	1,521	2,784
In-Pit Sump (at full pit development)	18.8	3,136	3,778	6,914
Dam 2 (polishing dam)	1.0	17	201	208
Dam 1 (clean water)	33.5	-	6,732	6,732

The In-Pit Sump is unlikely to overtop as the quarry void will be many orders of magnitude larger than the required volume for the design storm at all stages of the development.

Dam 2 is likely to be approximately 2,500 metres cubed in volume and will be more than sufficient to contain the design storm event. It should be noted that transfer of water from the in-Pit Sump is via pumping only. The Dam 1 is not required to contain the design storm and will be used to source water for dust suppression and irrigation of rehabilitation. Excess water captured within Dam 1 will flow via a spillway back into natural drainage lines and back to the downstream environment.

Table 8. Estimated Dam Maximum Capacities

Dam Identification	Maximum Capacity (m^3)	Maximum Capacity (ML)	Contribution to MHRDC
In-Pit Sump (at full pit development)	7,000	7	Nil Water will not be retained within the pit
Dam 2	2,500	2.5	2.5
Dam 1	5,000	5.0	5.0
Existing Farm Dam	3,400	3.4	3.4
Total of Water Potentially Held	**17,900**	**17.9**	**10.9**
MHRDC Limit			**26.4**

All dams will be constructed in accordance with Blue Book principles and Standard Drawings are included in *Appendix A*.

Any new dams will require a Works Approval and Use Approval from Water NSW (below or above harvestable rights).

Plan of:	**Surface Water Assessment for Razorback Quarry, Running Stream - Catchments**	**Location:**	39 Razorback Road, Running Stream, NSW	**Source:**	Google Earth 25/10/2021 & NSW Clip & Ship Accessed October 2022 Zone MGA 55	**Plan By:**	TO/JD
Figure:	**FIVE**	**Council:**	Mid-Western Regional Council	**Survey:**	NSW Government Spatial Services, October 2012 Survey, Accessed Through Elvis & Clip & Ship October 2022	**Project Manager:**	TO
Version/ Date:	V2 21/11/2022	**Tenure:**	Not Applicable	**Projection:**	GDA2020/MGA Zone 55 EPSG:7855		
Our Ref:	12453_SU_RBQ_EIS_SWA_Q005_V2_F5	**Client:**	Space Urban Pty Ltd	**Contour Interval:**	1 Metre		

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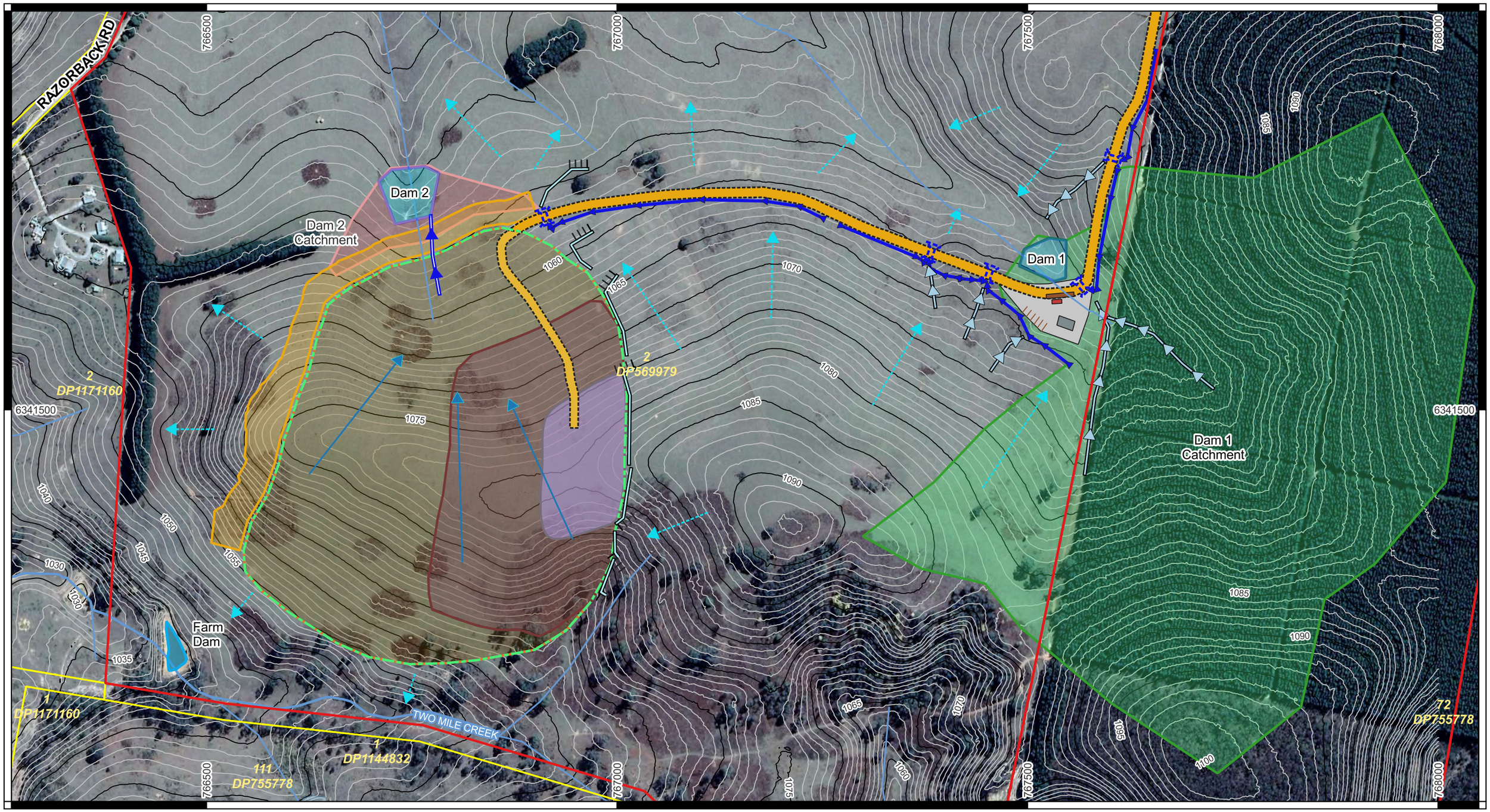

Legend

Site Features
- Property Boundary
- Lot Boundary (Cadastral)
- Road Corridor
- 1m Contour
- 5m Contour

Quarry Features
- Extraction Boundary
- Bund
- Office, Crib Room & Toilets
- Weighbridge
- Workshop Shed (20 x 12m)
- Haul Road
- Hardstand & Carpark

Water Management Features
- Existing Site Dam
- Poposed Sediment Dam
- Creek/Main Drainage Line
- Pipe
- Clean Water Diversion
- Drainage Line
- Culvert
- Catch Drain
- Clean Water Flow
- Dirty Water Flow

Catchments
- Dam 1 Catchment
- Dam 2 Catchment

Quarry Stages
- Stage One
- Stage Two
- Stage Three

Plan of:	**Surface Water Assessment for Razorback Quarry, Running Stream - Stage One Water Management**	**Location:**	39 Razorback Road, Running Stream, NSW	**Source:**	Google Earth 25/10/2021 & NSW Clip & Ship Accessed October 2022 Zone MGA 55	**Plan By:**	TO/JD		
Figure:	**SIX**	**Council:**	Mid-Western Regional Council	**Survey:**	NSW Government Spatial Services, October 2012 Survey, Accessed Through Elvis & Clip & Ship October 2022	**Project Manager:**	TO		
Version/ Date:	V2 21/11/2022	**Tenure:**	Not Applicable	**Projection:**	GDA2020/MGA Zone 55 EPSG:7855				
Our Ref:	12453_SU_RBQ_EIS_SWA_Q006_V2_F6	**Client:**	Space Urban Pty Ltd	**Contour Interval:**	1 Metre				

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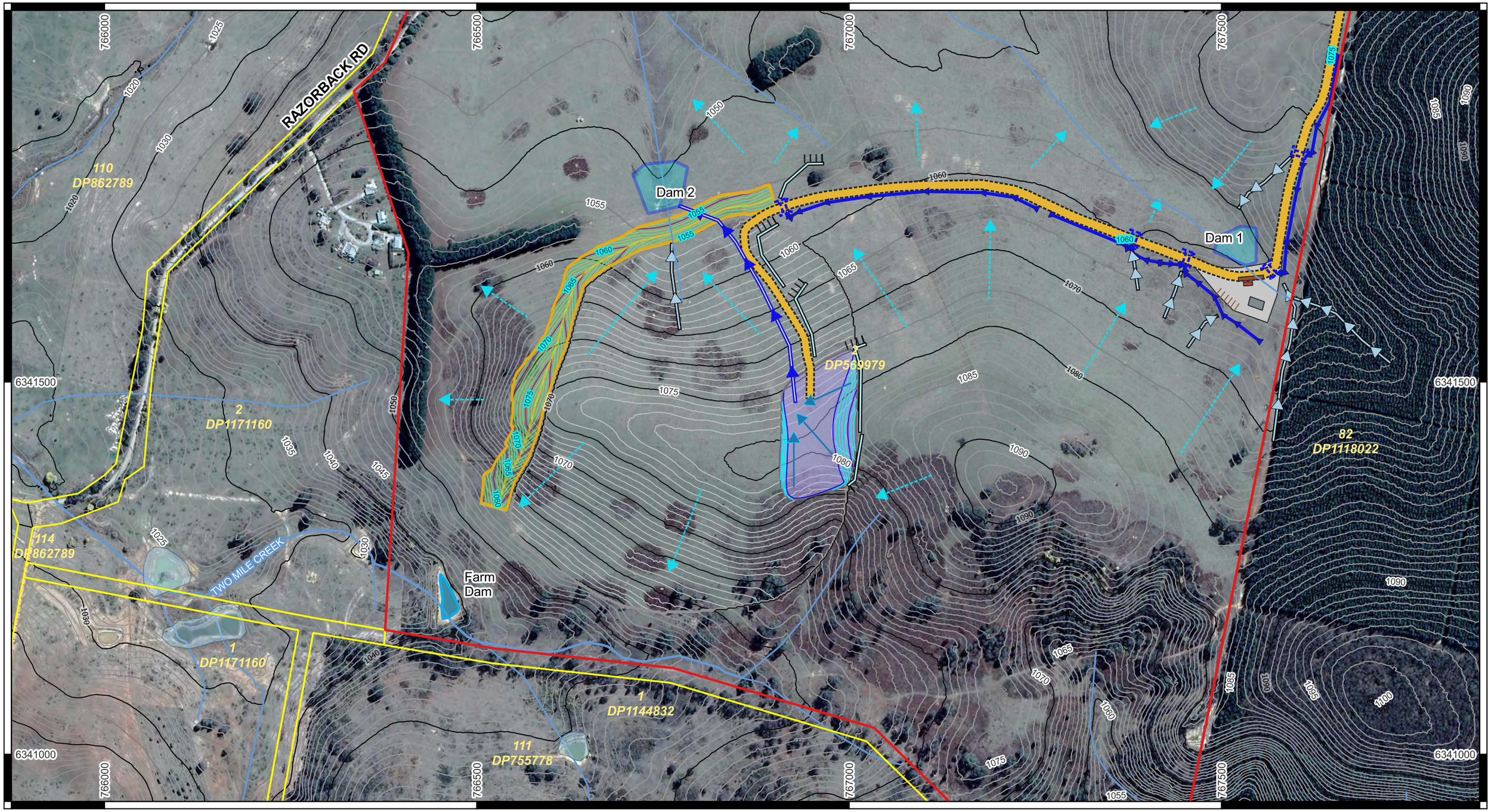

Legend

Site Features
- Property Boundary
- Lot Boundary (Cadastral)
- Road Corridor
- 1m Contour
- 5m Contour

Quarry Features
- Extraction Boundary
- Bund
- Office, Crib Room & Toilets
- Weighbridge
- Workshop Shed (20 x 12m)
- Haul Road (Stage One)
- Hardstand & Carpark

Water Management Features
- Existing Site Dam
- Poposed Sediment Dam
- Creek/Main Drainage Line
- Pipe
- Clean Water Diversion
- Drainage Line
- Culvert
- Catch Drain
- Clean Water Flow
- Dirty Water Flow

Quarry Stages
- Stage One
- 1m Contour (Stage One & Bund)
- 5m Contour (Stage One & Bund)

Plan of:	**Surface Water Assessment for Razorback Quarry, Running Stream - Stage Two Water Management**	**Location:**	39 Razorback Road, Running Stream, NSW	**Source:**	Google Earth 25/10/2021 & NSW Clip & Ship Accessed October 2022 Zone MGA 55	**Plan By:**	TO/JD
Figure:	**SEVEN**	**Council:**	Mid-Western Regional Council	**Survey:**	NSW Government Spatial Services, October 2012 Survey, Accessed Through Elvis & Clip & Ship October 2022	**Project Manager:**	TO
Version/ Date:	V2 21/11/2022	**Tenure:**	Not Applicable	**Projection:**	GDA2020/MGA Zone 55 EPSG:7855		
Our Ref:	12453_SU_RBQ_EIS_SWA_Q007_V2_F7	**Client:**	Space Urban Pty Ltd	**Contour Interval:**	1 Metre		

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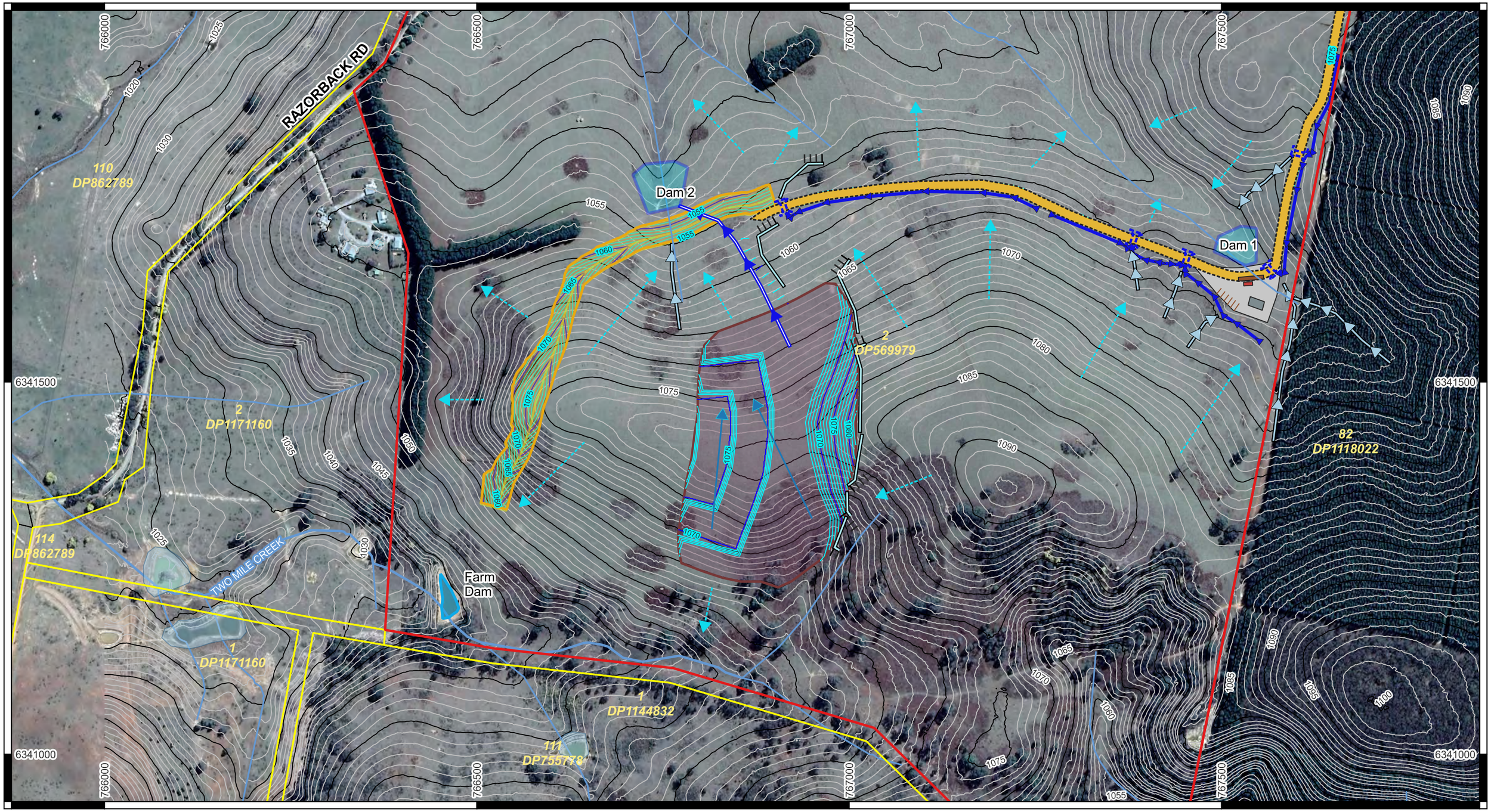

Legend

Site Features
- Property Boundary
- Lot Boundary (Cadastral)
- Road Corridor
- 1m Contour
- 5m Contour

Quarry Features
- Extraction Boundary
- Bund
- Office, Crib Room & Toilets
- Weighbridge
- Workshop Shed (20 x 12m)
- Haul Road (Stage Two)
- Hardstand & Carpark

Water Management Features
- Existing Site Dam
- Poposed Sediment Dam
- Creek/Main Drainage Line
- Pipe
- Clean Water Diversion
- Drainage Line
- Culvert
- Catch Drain
- Clean Water Flow
- Dirty Water Flow

Quarry Stages
- Stage Two
- 1m Contour (Stage Two & Bund)
- 5m Contour (Stage Two & Bund)

Plan of:	**Surface Water Assessment for Razorback Quarry, Running Stream - Stage Three & Four Water Management**	**Location:**	39 Razorback Road, Running Stream, NSW	**Source:**	Google Earth 25/10/2021 & NSW Clip & Ship Accessed October 2022 Zone MGA 55	**Plan By:**	TO/JD
Figure:	**EIGHT**	**Council:**	Mid-Western Regional Council	**Survey:**	NSW Government Spatial Services, October 2012 Survey, Accessed Through Elvis & Clip & Ship October 2022	**Project Manager:**	TO
Version/ Date:	V2 21/11/2022	**Tenure:**	Not Applicable	**Projection:**	GDA2020/MGA Zone 55 EPSG:7855		
Our Ref:	12453_SU_RBQ_EIS_SWA_Q008_V2_F8	**Client:**	Space Urban Pty Ltd	**Contour Interval:**	1 Metre		

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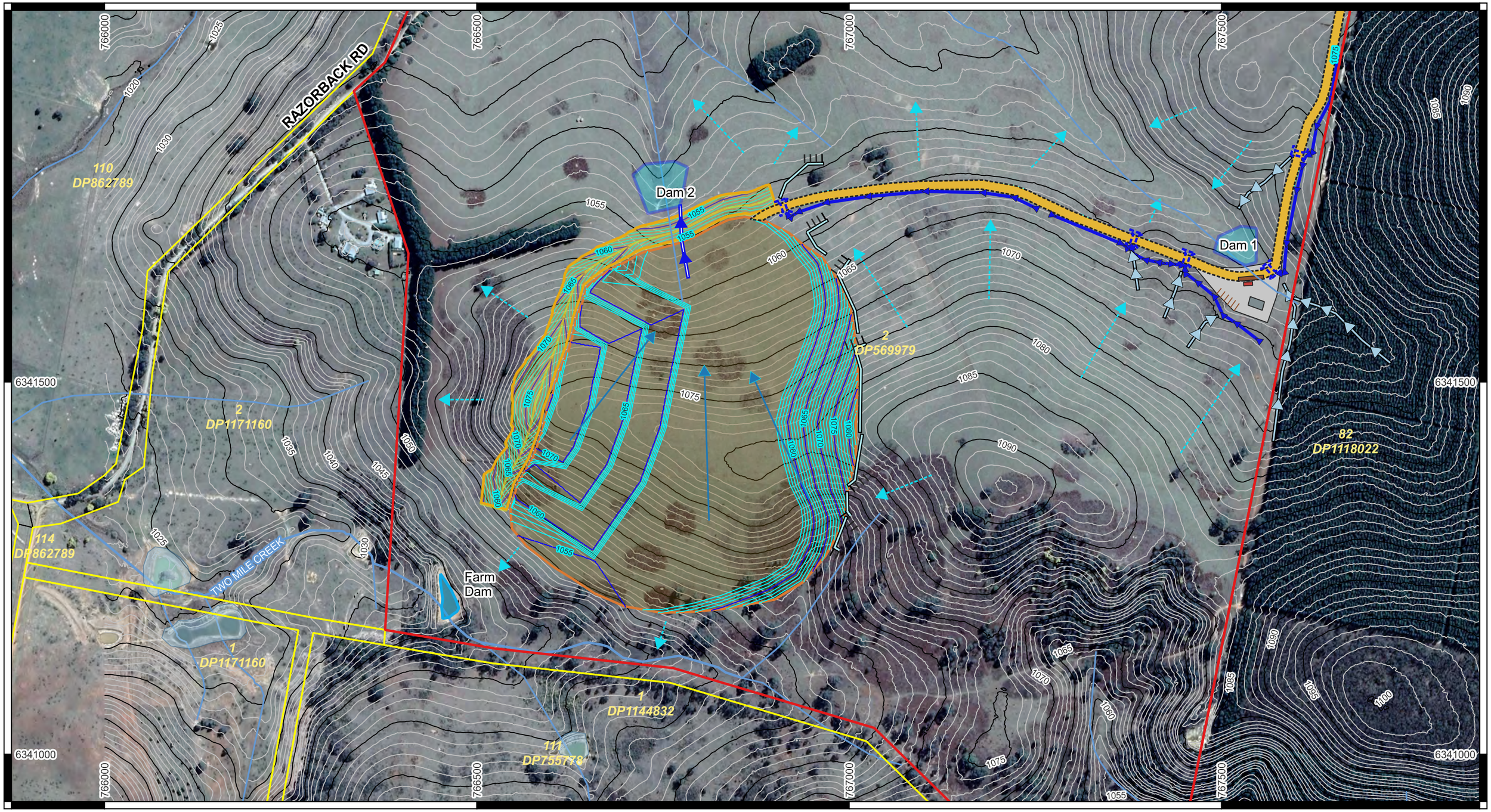

Legend

Site Features
- Property Boundary
- Lot Boundary (Cadastral)
- Road Corridor
- 1m Contour
- 5m Contour

Quarry Features
- Extraction Boundary
- Bund
- Office, Crib Room & Toilets
- Weighbridge
- Workshop Shed (20 x 12m)
- Haul Road (Stage Three & Four)
- Hardstand & Carpark

Water Management Features
- Existing Site Dam
- Poposed Sediment Dam
- Creek/Main Drainage Line
- Pipe
- Clean Water Diversion
- Drainage Line
- Culvert
- Catch Drain
- Clean Water Flow
- Dirty Water Flow

Quarry Stages
- Stage Three & Four
- 1m Contour (Stage Three & Four & Bund)
- 5m Contour (Stage Three & Four & Bund)

Plan of:	**Surface Water Assessment for Razorback Quarry, Running Stream - Final Landform**	**Location:**	39 Razorback Road, Running Stream, NSW	**Source:**	Google Earth 25/10/2021 & NSW Clip & Ship Accessed October 2022 Zone MGA 55
Figure:	**NINE**	**Council:**	Mid-Western Regional Council	**Survey:**	NSW Government Spatial Services, October 2012 Survey, Accessed Through Elvis & Clip & Ship October 2022
Version/ Date:	V2 21/11/2022	**Tenure:**	Not Applicable	**Projection:**	GDA2020/MGA Zone 55 EPSG:7855
Our Ref:	12453_SU_RBQ_EIS_SWA_Q009_V2_F9	**Client:**	Space Urban Pty Ltd	**Contour Interval:**	1 Metre

Plan By:	TO/JD
Project Manager:	TO

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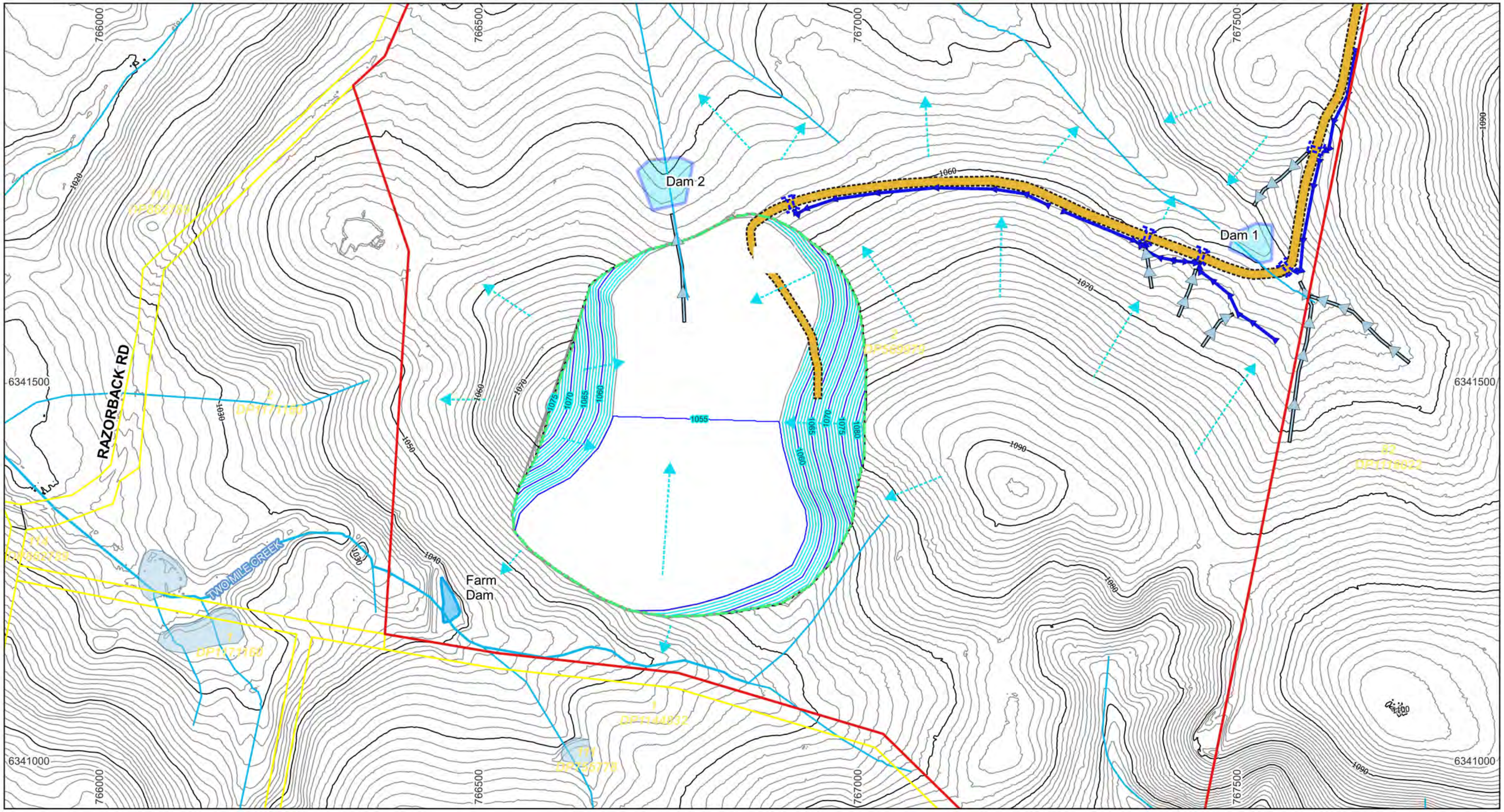

Legend

Site Features
- Property Boundary
- Lot Boundary (Cadastral)
- Road Corridor
- 1m Contour
- 5m Contour

Quarry Features
- Extraction Boundary
- Haul Road (Final)

Water Management Features
- Existing Site Dam
- Poposed Sediment Dam
- Creek/Main Drainage Line
- Pipe
- Clean Water Diversion
- Drainage Line
- Culvert
- Catch Drain
- Clean Water Flow
- Dirty Water Flow
- 1m Contour (Final)
- 5m Contour (Final)

5.1 WATER USE

The water usage on the site will be restricted to dust suppression activities and irrigation of rehabilitation. During extraction activities the Site is anticipated to use approximately 75 cubic metres of water per day. This equates to five 15,000 Litre water cart loads and will be sourced from the In-Pit Sump or the Dam 1. Campaigns are expected to be undertaken up to 4 times per annum for a duration of approximately 4 weeks. Thus, the total usage of water for dust suppression is estimated to be 1,500 cubic metres per campaign of 6,000 cubic metres per annum.

No other on-site uses for the water are planned at this stage. Potable water for the site office will be supplied by water tanks.

5.2 SOURCES AND SECURITY OF WATER SUPPLY

Dam 1 (see *Figure Five*) will have an estimated maximum capacity of 5,000 cubic metres and is sufficient to supply the dust suppression requirements per campaign, with time to replenish between. The in-pit sumps and Dam 2 may also be utilised as a source for dust suppression. If required due to dry conditions, potable water may be sourced for dust suppression purposes

5.3 DISCHARGE

The main pollutant in the surface water is entrained sediment from exposed surfaces.

5.3.1 Treatment of Water to be Discharged

The following outlines the procedure for preparing water for discharge from the In-Pit Sump:

- The water in the In-Pit Sump will be sampled and submitted for testing at a NATA approved laboratory;
- If the sampled water meets the EPL criteria the dam is suitable for discharge and may be emptied (see below for discharge procedure);
- If the sampled water does not meet the required criteria, the sump will be treated with flocculants (gypsum) and sufficient time allowed for sediment to settle is given before additional sampling and testing is conducted;
- Ideally the gypsum is mixed with water from the pit to create a slurry which is sprayed uniformly across the surface of the sump. The pump can be used to recirculate the sump water to encourage mixing; and
- The water will then be sampled and tested again to ascertain if it meets the discharge criteria. The above steps will be repeated until the water is of a suitable quality.

5.3.2 Discharge of Water

Once the water has been determined to be of suitable quality to discharge, the water will be pumped to Dam 2 to the north of the pit. From there the discharged water will eventually reach the unnamed creek via a natural drainage line by trickle feeding over the spillway when sufficient volume is held in the dam.

No concentrated flows will be permitted to leave the site. The spillway will be fed into an energy dissipater to minimise erosion impacts from the discharged water. The discharge will be supervised to ensure there is no adverse impacts noted such as visible sediment in discharge water, erosion and gullying, flooding etc. If impacts are noted discharge will cease immediately and remedial action undertaken.

5.4 CONTAMINATED WATER

The primary risk of contamination of the surface water, apart from sediment, is from the fuels and oils (lubricants and hydraulic fluid) used by the plant and machinery on the site. Refuelling and minor repairs and maintenance is undertaken in the hardstand areas or offsite. Fuel and oil are not stored on site. Diesel fuel is mainly contained within the plant and trucks and minor amounts held in a mobile refuelling tank which is filled off site as required. The site maintains a spill kit and all contractors are required to carry a spill kit on plant or equipment.

Due to the small volumes of hydrocarbons held on site it is unlikely that a spill would cause significant material harm to the environment. Should a spill occur it could be managed with the spill kits and localised contamination removed from the site.

A portable toilet will be installed on the site during campaigns. No sewerage or septic system will be required.

5.5 EROSION

5.5.1 Soil Characterisation

The catchment area and dam volumes for the site were estimated (see *Section 5*) to determine the risk of sediment-laden water leaving the site. The NSW Managing Urban Stormwater handbook, also known as the Blue Book, was used to make the determinations. Several assumptions have been made as listed below. The calculations have erred on the side of caution and should be considered a 'Worst Case Scenario'.

The Soil Hydrological Group for the soil materials is assumed to be D, very high run-off potential. Water moves into and through these soils very slowly when thoroughly wetted. They regularly shed run-off from most rainfall events.

Conservatively, sediment retention basins are designed using the Type D Soils calculations. This includes the sediment storage zone calculation using the estimated soil loss for the site over two months.

The likely soil loss is calculated with the Revised Universal Soil Loss Equation (RUSLE). The values of the other RUSLE factors are: P of 1.3 and the C is assumed to be 1.0 for bare soil. Calculations can be found in *Appendix A.*

The potential soil loss of the site has been calculated using *Managing Urban Stormwater, Soil and Construction, Volume 2E Mines and* Quarries for a 90th percentile, 5-day rainfall event assuming a non-sensitive receiving environment. Important site physical characteristics are identified in the table below.

Table 9. Soil Constraints and Characteristics

Constraint/Opportunity	Value
IFD:2 year, 6 hour storm	5.91 (from the BOM IFD data)
Slope Gradients	Low to Moderate (Average 6-20%)
Potential Erosion Hazard	Moderate
Soil Erodiblity	Moderate to High
Calculated Soil Loss	Up to 1,300 tonnes/Ha/yr depending on particular mine slopes.
Soil Loss Class	1 to 6 (Steeper slopes within the pit are at higher risk of erosion)
Soil Texture Group	Type D
Soil Hydrological Group	D
Runoff Coefficient	0.64 (Soil Hydrological Group D)

5.5.2 Erosion Control

Generally, the site is prone to moderate erosion, but this will be limited to the exposed worked areas of the mine. Eroded soils and sediment are captured within the in-pit sump and do not leave the site. Slopes are kept moderate where possible in the pit to reduce the erosion hazard.

5.5.2.1 General Instructions

The control of erosion and sedimentation at the site will focus on source reduction measures. In general, these measures will include:

- Reading any Surface and Groundwater Management Plan with any engineering plans and any other plans or written instructions issued in relation to development at the subject site;
- Ensuring contractors undertake all soil and water management works as instructed in this specification and constructed following the guidelines stated in the "Blue Book"; and
- Inform all subcontractors of their responsibilities in minimising the potential for soil erosion and pollution to downslope areas.

5.5.2.2 Works Sequence

All works are to be undertaken in the following sequence:

- Topsoil in new areas will be surveyed, mapped and the texture, thickness and quality described prior to stripping. Topsoil and overburden not for immediate use will be stockpiled in appropriate areas and limited to 2 metres in height and revegetated with temporary ground cover species, mulching or chemical stabilisers or binders if they are to remain in place for more than 30 days. A minimum of 70 percent cover is required for both mulch and vegetative covers;
- Construct earth banks (Stormwater Collection Drains) to divert as much clean water as possible and capture the dirty water in the extraction area;
- Undertake extraction activities in the new area;
- Rehabilitate lands in exhausted areas with overburden then topsoil and revegetate;
- Install barrier fencing to limit access to rehabilitated areas; and
- Ensure management practices are carried out to minimise areas being affected by wind and water erosion.

5.5.2.3 Erosion Control Instructions

The soil erosion hazard on the site will be kept as low as practicable by minimising disturbance. Some ways of doing this are outlined in *Table 10*. Extraction will take place within a defined work area. Entry to land not involved directly in the extraction process will be prohibited and will be managed as natural grassland. Vehicular access to the site will be limited to that essential for extraction or rehabilitation.

Table 10. Limitations to Access

Landuse	Access Limitations	Comments
Extraction	Land disturbances beyond five (preferably two) metres from the edge of the operations are prohibited.	All site workers should clearly recognise these areas and they should be clearly marked — suitable materials include barrier mesh, sediment fencing, etc. The project manager will determine their actual location on site. They can vary in position to conserve existing vegetation best while being considerate of the needs of efficient works activities.
Access Roads	Roads and tracks are limited to a width that are the minimum necessary to allow safe operation of heavy equipment	
Remaining Lands	Land disturbances are prohibited except for essential management works.	

Rehabilitation in the context of this report means:

Achieving a C-factor (Revised Universal Soil Loss Equation) of less than 0.1 and setting in motion a program that should ensure it will drop permanently, by reducing the risk of erosion by vegetation, paving, armouring, etc. as soon as practicable after extraction activities cease.

It should be noted that the cover factor, C, is the ratio of soil loss from land under specified crop or mulch conditions to the corresponding loss from continuously tilled, bare soil. A C-factor of 1.0 corresponds to that of bare soil.

While C-factors are likely to rise to 1.0 during the work's program, they should not exceed those given in *Table 11* within the specified times.

Table 11. Maximum acceptable C-factors at nominated times during works

Lands	Maximum C-Factor	Remarks
Waterways and other areas subjected to concentrated flows, post construction.	0.05	Applies after ten working days from completion of formation and before they are allowed to carry any concentrated flows. Flows are limited to those indicated in "Blue Book". Foot and vehicular traffic are prohibited in these areas.
Stockpiles, post clearance	0.1	Applies after ten working days from completion of formation.
All lands, including waterways and stockpiles during construction	0.15	Applies after 20 working days of inactivity, even though works might continue later.

Note: *working days* does not include public holidays, weekends or days when work is not possible due to wet weather.

The required C factors can be achieved in the short term (temporary protection for up to six months) with either:

- a suitable soil binder in areas of sheet flow, e.g. topsoil stockpiles; and
- a temporary vegetative cover.

Any soil binders applied should be employed following the manufacturer's instructions.

A suggested listing of suitable plant species is shown in *Table 12.* Before sowing, additional tests should be undertaken to assess the requirements of ameliorants such as lime to help plant growth.

Table 12. Plant Species for Temporary Cover

Sowing Season	Seed Mix
Autumn/Winter	Oats @ 40kg/Ha Japanese Millet @ 10kg/Ha
Spring/Summer	Oats @ 20kg/Ha Japanese Millet @ 20kg/Ha

While ever the C-factor is higher than 0.1, maintain the lands in a condition that resists removal by wind. This can be achieved by keeping the soil moist (not wet) by sprinkling with water and where practicable, leaving the surface in a cloddy state. Notwithstanding the above, schedule works so that the duration from the conclusion of land shaping to completion of final stabilisation is less than 10 days on slopes steeper than 30 per cent and 20 days on slopes less steep than 30 per cent.

Lands planted recently with grass species will be watered regularly until an effective cover has properly established and plants are growing vigorously. Follow-up seed and fertiliser will be applied as necessary in areas of minor soil erosion and/or inadequate vegetative protection. Where practicable, foot and vehicular traffic will be kept away from all recently stabilised areas.

Topsoil is to be stripped in a moist condition to avoid pulverisation and dust and topsoil stockpiles are not to exceed 2m in height with a minimum crest width of 2m. They should be seeded with a temporary vegetation cover if stockpiles are to remain longer than 30 days. Stockpiles are to be located at least five metres from areas of likely concentrated or high velocity flows, especially drainage lines and access roads. If necessary, earth banks or drains will be constructed to divert localised run-on. Soil materials are to be replaced in the same order they are removed from the ground. It is particularly important that all subsoils are buried, and topsoils remain on the surface at the completion of works.

Earth batters can have maximum gradients of 2(H):1(V) during the works program but will be laid back to lower grades before the rehabilitation program starts. Final batter gradients will be between 3(H):1(V) and 4(H):1(V).

All waterways, drains, spillways and outlets will be constructed to be stable in accordance with the "Blue Book" for soils with high erodibilities.

5.6 POST CLOSURE

The impact of the proposed final landform on surface water is not expected to be significant. The final landform will be self-draining. Surface and Groundwater Management Plan will remain in place until the water quality from the site meets the target objectives for the area. With the use of vegetation and reduced slopes it is expected that there will be limited risk of impacts on surface water post closure.

6 Surface Water Impacts

6.1 CATCHMENT SURFACE FLOW VOLUMES

Although the site will increasingly divert surface water to the pit as quarrying progresses, it will have very little impact on the total volume of water flowing into the unnamed creek to the north and Two Mile creek to the south. Water captured within the pit will be returned to the downstream environment via the proposed sediment dam. All dams will be within the Harvestable Rights for farm dams and thus retaining less that 10% of the total rainfall for the property.

6.2 DOWNSTREAM WATER USERS

Downstream land use is primarily rural. The watercourses are generally only used for stock water or recreational purposes and not large-scale irrigation. The capture of the surface water on the site is not expected to adversely impact downstream water users.

6.3 RIPARIAN AND ECOLOGICAL VALUES OF THE WATERCOURSES

The project is not expected to have any significant impacts on the existing condition of nearby watercourses, including the unnamed creek to the north and Two Mile Creek to the south. These systems are characterised by degraded environmental conditions due to agricultural pursuits and land clearing.

There will be no increase in the frequency of discharges over and above current levels in the short to medium term and therefore no additional impacts on riparian environments, including geomorphology and environmental flows. In the long-term, flows are likely to be returned to the predevelopment levels.

6.4 FLOODING

The development is not located in a flood zone nor will it exacerbate flood potential within the site nor downstream.

6.5 CUMMULATIVE IMPACTS

With the sediment and erosion controls in place, it is predicted that there will be negligible impacts to surface water above that experienced by the current system due to surrounding agricultural and forestry landuse.

7 Groundwater Impacts

7.1 GROUNDWATER QUALITY

The quarry operations are not expected to encounter groundwater due to the ridgeline setting and maximum depth of extraction.

The deepest drillhole, of approximately 30 metres total depth, BH7, (see *Figure Eleven* and *Appendix C*) was sunk during the resources assessment phase, indicates that groundwater was encountered at approximately 1049m AHD [(Ref 4)]. This is 5-6 m below the proposed quarry floor at 1055 AHD, as such the quarry is not expected to directly impact groundwater in the area.

As such, the groundwater quality is not expected to be impacted. There is a small risk of hydrocarbon contamination should a fuel spill occur, but the volumes of fuel held on site during campaigns is very low. Contractors are also required to carry spill kits to contain any accidental spills.

7.2 GROUNDWATER QUANTITY

The quarry is not expected to 'take' groundwater and will have minimal impact on the local aquifers, noting the sandy nature of the quarry resource and surrounding area, is likely to provide a recharge area for the groundwater table due to the higher permeability.

7.3 GROUNDWATER DEPENDANT ECOSYSTEMS (GDE)

7.3.1 Aquatic GDEs

Two Mile Creek is considered to have a High Potential for Ground Water Dependant Aquatic Ecosystems (National Assessment) with and an In Flow-dependent Ecosystem (IDE) likelihood of 4 (from the BOM GDE web portal http://www.bom.gov.au/water/groundwater/gde/map.shtml).

The likelihood grid for inflow-dependent ecosystems expresses the likelihood that landscapes are accessing water in addition to rainfall. The likelihood is expressed as a range of values between 1 (low) and 10 (high), where 10 indicates landscapes that are most likely to access additional water sources. The additional water source may be soil water, surface water, or groundwater.

It is unlikely that the site will intersect groundwater and there will be minimal discharge of water and impact to the surface flows to the GDE during the development. Therefore, the impact to the aquatic GDE in Two Mile Creek is considered low.

Plan of:	**Surface Water Assessment for Razorback Quarry, Running Stream - Aquatic GDE's Locations**	**Location:**	39 Razorback Road, Running Stream, NSW	**Source:**	Google Earth 25/10/2021 & NSW Clip & Ship Accessed October 2022 Zone MGA 55	**Plan By:**	TO/JD
Figure:	**TEN**	**Council:**	Mid-Western Regional Council	**Survey:**	NSW Government Spatial Services, October 2012 Survey, Accessed Through Elvis & Clip & Ship October 2022	**Project Manager:**	TO
Version/ Date:	V2 21/11/2022	**Tenure:**	Not Applicable	**Projection:**	GDA2020/MGA Zone 55 EPSG:7855		
Our Ref:	12453_SU_RBQ_EIS_SWA_Q010_V2_F10	**Client:**	Space Urban Pty Ltd	**Contour Interval:**	1 Metre		

N

0 150 300 450 m

vgt environmental compliance solutions and laboratories

This figure may be based on third party data which has not been verified by vgt and may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and vgt does not warrant its accuracy.

Legend

Site Features
- Property Boundary
- Road Corridor

Quarry Features
- Bund
- Office, Crib Room & Toilets
- Weighbridge
- Workshop Shed (20 x 12m)
- Haul Road
- Hardstand & Carpark

Water Management Features
- Existing Site Dam
- Poposed Sediment Dams
- Creek/Main Drainage Line

Quarry Stages
- Stage One
- Stage Two
- Stage Three

Aquatic GDE's
- High Potential GDE - from National Assessment
- Low Potential GDE - from National Assessment
- Moderate Potential GDE - from National Assessment
- Unclassified Potential GDE - from Regional Studies

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7.3.2 Terrestrial GDEs

To the south of the site, Two Mile Creek is identified as generally containing Terrestrial GDEs of a Low Potential GDE (Regional Study) with an IDE likelihood of 8 i.e. Red stringybark- Brittle Gum- Inland Scribbly gum dry open forest of the tablelands; South Eastern. The south-eastern portion of the proposed extraction envelope also maps this Terrestrial Ecosystem.

A pocket of Moderate to High Potential GDE (Apple Box- Yellow Box dry grassy woodland of the South Eastern Highlands Bioregions), with an IDE likelihood of 4, has been identified to the south to which the project will partially encroach upon. This comprises of approximately 0.25 Ha of PCT 1191*: Snow Gum - Candle Bark woodland on broad valley flats of the tablelands and slopes, South Eastern Highlands Bioregion* (Low Condition) **(Ref 3)**.

Located centrally within the property is a Terrestrial GDE (Red stringybark- Brittle Gum- Inland Scribbly gum dry open forest of the tablelands; South Eastern) of Low Potential and an IDE likelihood of 4. The access track/haul road will bisect this community.

The site is considered Category 1 Exempt Land under Local Land Service Act 2013 which affords dispensation when undertaking clearing for the project **(Ref 2)**, which will occur to the vegetation in the south of the quarry footprint. The Biodiversity Assessment (MJD Environmental 2022) concluded that there would be no significant impact to ecological communities due to the clearing of vegetation on the site.

Plan of:	**Surface Water Assessment for Razorback Quarry, Running Stream - Terrestrial GDE's Locations**	**Location:**	39 Razorback Road, Running Stream, NSW	**Source:**	Google Earth 25/10/2021 & NSW Clip & Ship Accessed October 2022 Zone MGA 55	**Plan By:**	TO/JD
Figure:	**ELEVEN**	**Council:**	Mid-Western Regional Council	**Survey:**	NSW Government Spatial Services, October 2012 Survey, Accessed Through Elvis & Clip & Ship October 2022	**Project Manager:**	TO
Version/ Date:	V2 21/11/2022	**Tenure:**	Not Applicable	**Projection:**	GDA2020/MGA Zone 55 EPSG:7855		
Our Ref:	12453_SU_RBQ_EIS_SWA_Q011_V2_F11	**Client:**	Space Urban Pty Ltd	**Contour Interval:**	1 Metre		

N

0 150 300 m

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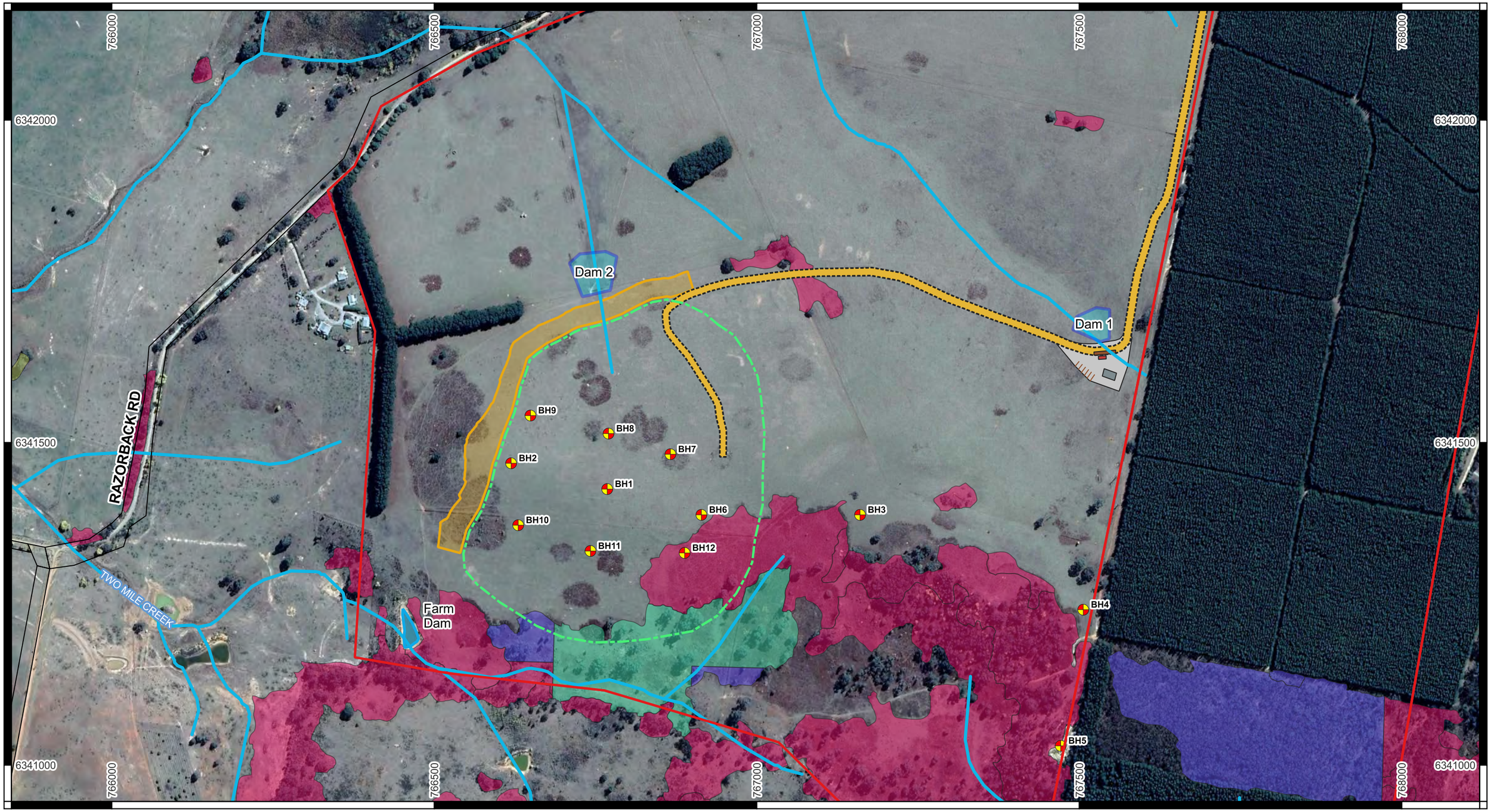


Legend

Site Features
- Property Boundary
- Road Corridor

- Borehole Location

Quarry Features
- Extraction Boundary

- Bund
- Office, Crib Room & Toilets
- Weighbridge

- Workshop Shed (20 x 12m)
- Haul Road
- Hardstand & Carpark

Water Management Features
- Existing Site Dam
- Poposed Sediment Dam

- Creek/Main Drainage Line

Terrestrial GDE's
- High Potential GDE - from Regional Studies
- Low Potential GDE - from Regional Studies
- Moderate Potential GDE - from Regional Studies

8 Water Balance

8.1 OVERVIEW

The objective of the water balancing modelling was to assess the ability of the project site to provide on-site water detention and to understand potential changes in surface water drainage. Under direction from the 'Blue Book' and EPL requirements, the model investigated the following:

- Determine if the In-Pit Sump will overtop during the next 10 years of operation using historical rainfall data as a guide; and
- Demonstrate that there is sufficient water security for the site operations over the next 10 years of operation.

The primary source of water on the site is from incident rainfall collected into the In-Pit Sump, the proposed Dam 1 and Dam 2. A farm dam is also located on the site to the west of the current pit. Water will be consumed on the site for dust suppression purposes. It may also be utilised in the future to irrigate rehabilitated areas; however, this has not been accounted for in the water balance due to the expected irregularity of the irrigation.

8.2 MODELLING ASSUMPTIONS

The following assumptions and inputs were applied during the development of the water balance model:

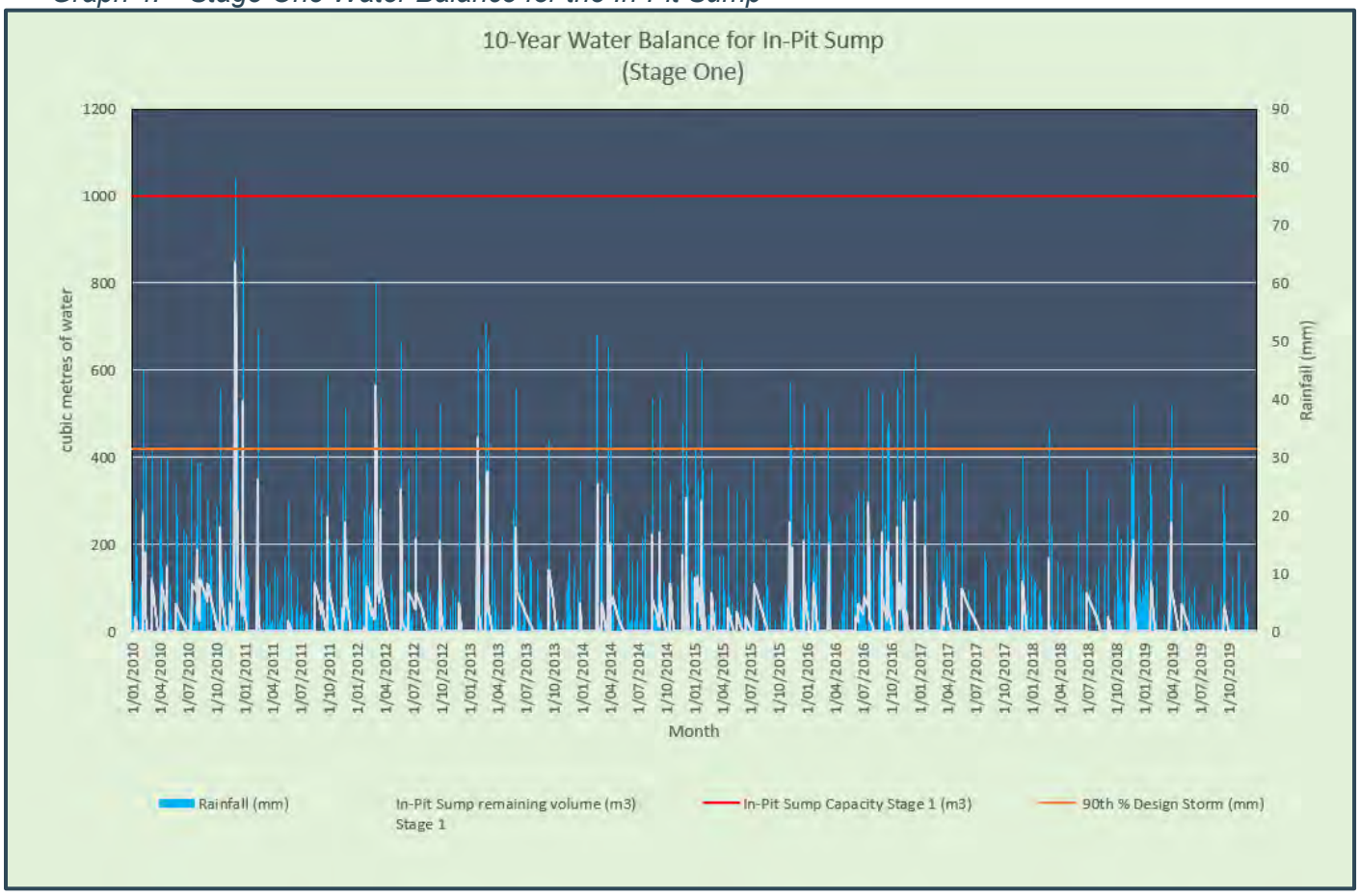
- The water balance model has been run using the first, second and final extent of the void as the water storage area;
- The proposed Dam 2 (polishing dam) volume has been estimated to be 2,500m^3. It only receives incident rainfall from its immediate catchment (1Ha) and water from the In-Pit Sump when pumping occurs. It has not been modelled in the water balance;
- The catchment area for surface water within the pit for Stage One, Stage Two and the Final Stage are 1.7Ha, 7.6Ha and 18.8Ha respectively;
- To ensure a conservative and realistic assessment is being carried out, 10mm of rainfall will be applied prior to the expected runoff to commence. It is industry standard practice to provide wetting of the catchment and allows the dams retain some water, as in practice the dams generally have carryover of water from previous flood events .i.e. they are rarely dry;
- To understand how the system operates under both wet and dry conditions, the existing site scenarios were modelled with the application of a daily time step for a 10-year period, 2010 to 2019. This time period includes one of the driest and also some of the wettest years over the period of time records haven been held. The average rainfall for the period is typical of the historical average for the area;
- Historical rainfall data from the Bureau of Meteorology (Running Stream (Brooklyn)- site 063012) has been used for the years 2010 to 2019;
- The wettest year and driest years were 2010 (1,283mm) and 2019 (461mm) respectively;
- A runoff coefficient of 0.64 (from the blue book) has been used assuming a Soil Hydrological Group of D;
- Maximum In-Pit Sump volume before overtopping have been calculated from SURPAC 3D modelling of the stage voids;
- The affective area of evaporation has been assumed to be the dam surface areas. The actual area will vary according to the dam volume but for this calculation the area is assumed to be 1,700m^2 and vertical dam walls are assumed for ease of calculation;
- A pan evaporation factor of 0.75 for the water storage (to convert recorded pan evaporation to pond surface evaporation);
- Groundwater seepage into the dam is assumed to be negligible;
- Dissipation from the dam is assumed to be negligible;
- Evaporation rates were obtained from the nearest available comparative site which was the Bureau of Meteorology (Bathurst Agricultural Station- site 063005). Where actual data was not available, historical averages were applied;

- Discharge from the pit is achieved via pumping. The flow rate averages 100L/min and is assumed to flow 24 hours a day when the EPL conditions are met. This approximates 144 cubic metres of water released per day when required; and
- Dust suppression water is supplied by the proposed Dam 1, which has a nominal capacity of 5,000 metres cubed and a catchment of 33.5Ha. Water from the Pit and Dam 2 may be used in conjunction with Dam 1 but for the purposes of modelling, only water from Dam 1 has been included, as the worst-case scenario.

8.2.1 Stage One

The 10-year modelling period indicates that the In-Pit Sump is unlikely to flood a portion of the pit floor, even when rainfall exceeds the design storm event. In extreme rainfall periods the treatment and emptying of the in-Pit Sump may exceed a 5-day period however, the quarry void itself is many orders of magnitude larger than the In-Pit Sump (~62,000 m^3) and the risk of uncontrolled discharge is negligible.

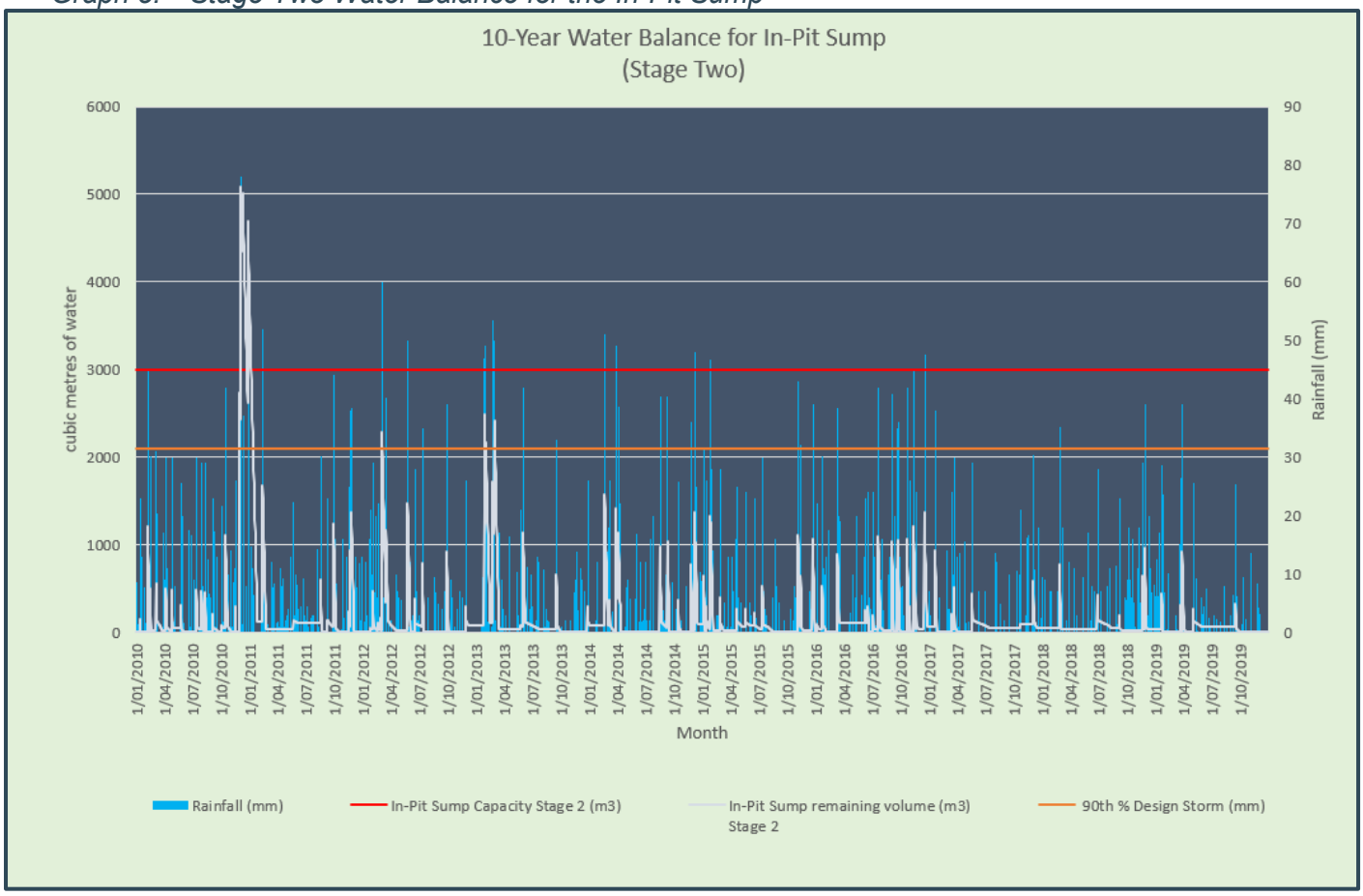
Graph 4. Stage One Water Balance for the In-Pit Sump



8.2.2 Stage Two

The 10-year modelling period indicates that the In-Pit Sump may flood a portion of the pit floor during Stage Two, when rainfall exceeds the design storm event (219mm over an 8-day period). In extreme rainfall periods the treatment and emptying of the in-Pit Sump may exceed a 5-day period however, the quarry void (424,000m^3) itself is many orders of magnitude larger than the In-Pit Sump and the risk of uncontrolled discharge is negligible.

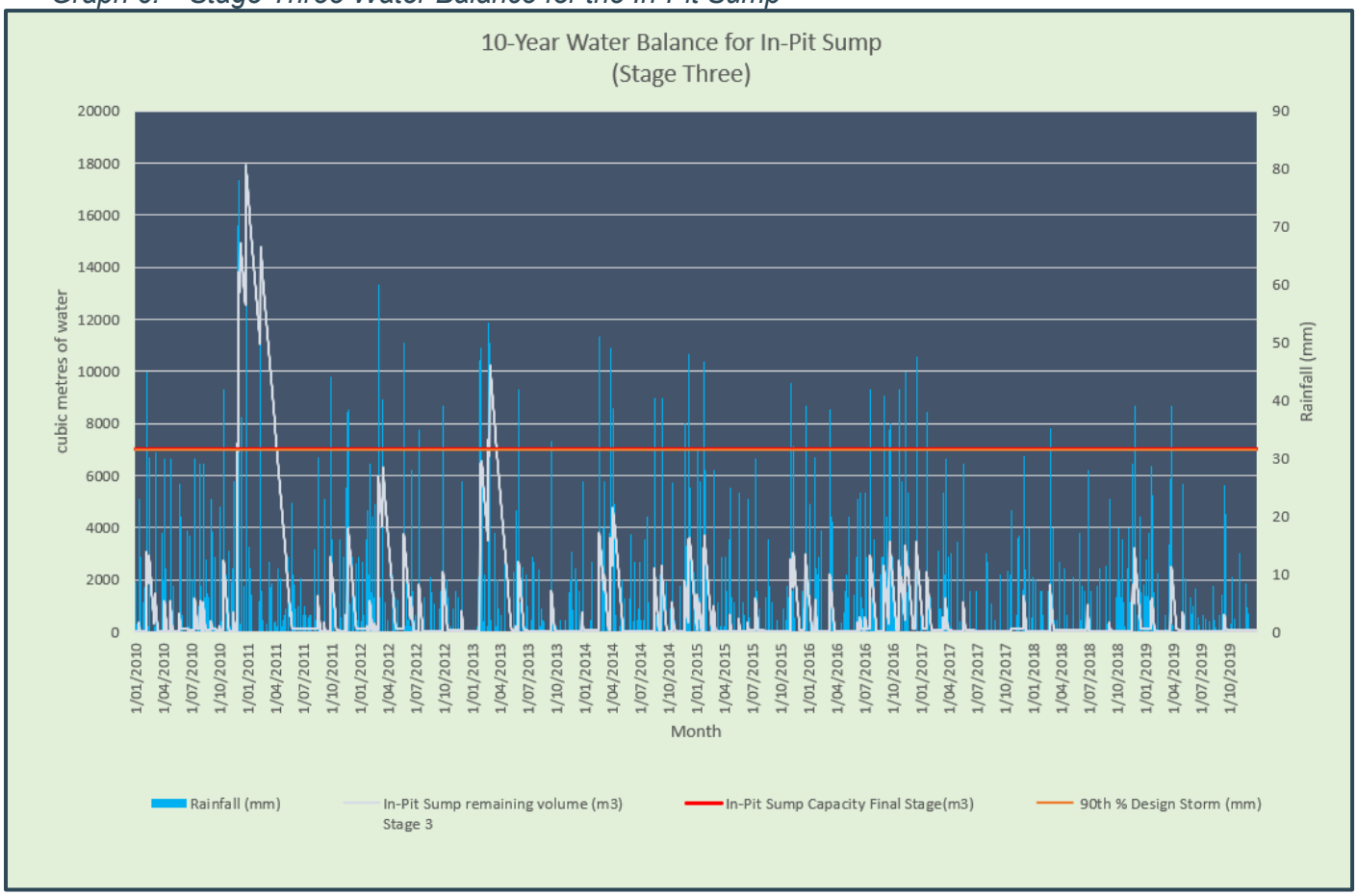
Graph 5. Stage Two Water Balance for the In-Pit Sump



8.2.3 Stage Three

The 10-year modelling period indicates that the In-Pit Sump may flood the pit floor during Stage Three, when rainfall exceeds the design storm event (219mm over an 8-day period). In extreme rainfall periods the treatment and emptying of the in-Pit Sump may exceed a 5-day period however, the quarry void (2,200,000m^3) itself is many orders of magnitude larger than the In-Pit Sump and the risk of uncontrolled discharge is negligible

Graph 6. Stage Three Water Balance for the In-Pit Sump



8.2.4 Clean Water Dam and Dust Suppression

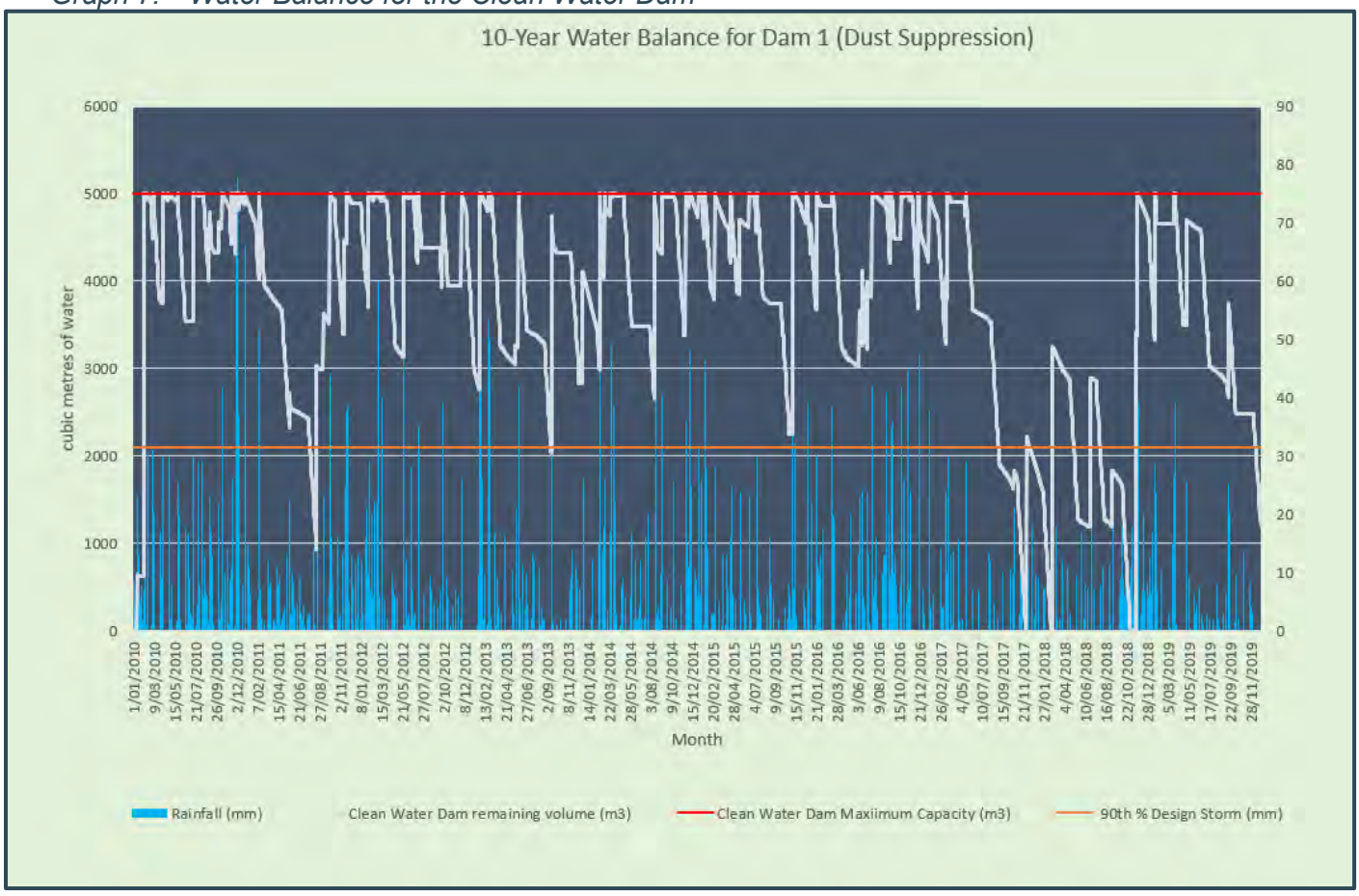
As stated previously, during extraction activities the Site is anticipated to use approximately 75 cubic metres of water per day. This equates to five 15,000 Litre water cart loads and will be sourced from the In-Pit Sump or the Clean Water Dam. Campaigns are expected to be undertaken up to 4 times per annum for a duration of approximately 4 weeks.

For the purposes of the water balance, water was sourced from Dam 1 as it is more likely to contain water during campaign periods than the In-Pit Sump.

The Dam 1 will have an estimated maximum capacity of 5,000 cubic metres and is sufficient to supply the dust suppression requirements per campaign, with time to replenish in-between. If required due to dry conditions, water may be sourced from the other site dams or potable water may be imported for dust suppression purposes.

As can be seen from the graph below, Dam 1 will generally have sufficient capacity to supply water for dust suppression purposes. The exception may occur during extremely dry periods.

Graph 7. Water Balance for the Clean Water Dam



9 Risk Assessment

A risk-based approach has been undertaken to assess the impacts and mitigation measures in accordance with the *Risk Based Framework for Considering Water Health and Outcomes in Strategic Land-use Planning Decisions (OEH & EPA 2017)*.

9.1 CONTEXT OF PROPOSED DEVELOPMENT

The context of the proposal is described in *Section 4.*

9.2 EXISTING AND PROPOSED LANDUSE

The existing landuse, surrounding landuses and existing environment are discussed in *Section 4*. The proposed landuse of quarrying is permissible within the RU1- Primary Production zoned land within the Mid-Western Regional Council Local Government Area (LGA). Quarrying will occupy only a portion of the total holding with existing landuses remaining active.

9.3 NSW WATER QUALITY AND RIVER FLOW OBJECTIVES

Water Quality Objectives (WQOs) and the River Flow Objectives (RFOs) for the Macquarie-Bogan River Catchment, have been defined by the Office of Environment and Heritage (OEH) and have been used to develop plans and actions affecting water quality and river health. Suggested objectives and key indicators are shown below as well as an assessment of how the land use activity will affect the indicator.

9.4 EFFECTS BASED RISK ASSESSMENT

The following describes the risk based assessment on effects on the Water Quality Objectives (WQOs) and the River Flow Objectives (RFOs) for the Macquarie-Bogan River Catchment.

Table 13. Effect Base Assessment of Macquarie – Bogan River Water Quality for Aquatic Ecosystems

Objective	Indicator	Numerical criteria (trigger values)	Effect of Land Use Activity on Indicator	Effectiveness of Proposed Management Responses	Risk of Impact	Strategic Impact Assessment (feasibility of achieving intended outcomes)
To maintain or improve the ecological condition of waterbodies and their riparian zones over the long term.	Total phosphorus	Upland rivers: 20 µg/L	The quarrying activity is not a source of phosphorus and will not contribute phosphorus to the aquatic ecosystem. Rehabilitation activities such as fertilisation of areas to be revegetated may contribute phosphorus at levels equivalent to surrounding agricultural practices.	Effective. Any fertiliser to be applied to rehabilitation areas will be at a rate determined though analysis of growth medium material and requirement of target species to be planted. Rate of release of phosphorus in fertilisers may be limited by using slow-release fertilisers.	Low	Control measures are cost effective and feasible.
	Total nitrogen	Upland rivers: 250 µg/L	The quarrying activity is not a source of nitrogen and will not contribute nitrogen to the aquatic ecosystem. Land clearing and stockpiling of topsoil and vegetation may release nitrogen to the waterways. Rehabilitation activities such as fertilisation of areas to be revegetated may contribute nitrogen at levels equivalent to surrounding agricultural practices.	Effective. Vegetation and topsoil stockpiles will be suitably stabilised and not located in areas of concentrated flows. Any fertiliser to be applied to rehabilitation areas will be at a rate determined though analysis of growth medium material and requirement of target species to be planted. Rate of release of nitrogen in fertilisers may be limited by using slow-release fertilisers.	Low	Control measures are cost effective and feasible.
	Chlorophyll-a	Upland rivers: not applicable	-	-	-	-
	Turbidity	Upland rivers: 2–25 NTU	Quarrying activities may be a source of turbidity.	Effective Erosion and sediment control devices will be installed prior to earthworks and will be designed and operated in accordance with the Blue Book.	Low	Control measures are cost effective and feasible.
	Salinity (electrical conductivity)	Upland rivers: 30–350 µS/cm	The quarrying activity is not considered a source of salinity and will not contribute salinity to the aquatic ecosystem.	Effective Erosion and sediment control devices will be installed prior to earthworks and will be designed and operated in accordance with the Blue Book.	Low	Control measures are cost effective and feasible.

Objective	Indicator	Numerical criteria (trigger values)	Effect of Land Use Activity on Indicator	Effectiveness of Proposed Management Responses	Risk of Impact	Strategic Impact Assessment (feasibility of achieving intended outcomes)
	Dissolved oxygen	Upland rivers: 90–110%	Quarrying activities are unlikely to reduce oxygen levels in waterways, particularly due to biological activity.	Effective No discharge of water from the site will occur unless the discharge water quality criteria has been met.	Low	Control measures are cost effective and feasible.
	pH	Upland rivers: 6.5–8.0	Quarrying activities may result in a deviation from baseline pH.	Effective No discharge of water from the site will occur unless the discharge water quality criteria has been met.	Low	Control measures are cost effective and feasible.
	Temperature	See ANZECC 2000 Guidelines, table 3.3.1. (>80%ile and <20%ile)	Quarrying activities are unlikely to change the natural temperature variations of waterways.	Effective No discharge of water from the site will occur unless the discharge water quality criteria has been met.	Low	Control measures are cost effective and feasible.
	Chemical contaminants or toxicants	See ANZECC 2000 Guidelines, chapter 3.4 and table 3.4.1.	Quarrying activities are unlikely to be a source of chemical contaminants or toxicants. Fuel may be the most likely contaminant.	Effective Only small volumes of fuel are held on site and only during quarrying or rehabilitation activities. No fuel is stored on site and spill kits are available.	Low	Control measures are cost effective and feasible.
	Biological assessment indicators	This form of assessment directly evaluates whether management goals for ecosystem protection are being achieved (e.g. maintenance of a certain level of species diversity, control of nuisance algae below a certain level, protection of key species, etc). Many potential indicators exist and these may relate to single species, multiple species or whole communities. Recognised protocols using diatoms and algae, macrophytes, macroinvertebrates, and fish populations and/or communities may be used in NSW and interstate (e.g. AusRivAS).	Not Applicable. There is no permanent water in the water courses on the site.	-	-	-

9.4.1 Macquarie – Bogan River Water Quality Objectives for Livestock Water Supply

Table 14. Effect Base Assessment of Macquarie – Bogan River Water Quality for Livestock Water Supply

Objective	Indicator	Numerical criteria (trigger values)	Affect of Land Use Activity on Indicator	Effectiveness of Proposed Management Responses	Risk of Impact	Feasibility of Achieving Management Response
To protect water quality to maximise the production of healthy livestock.	Algae & blue-green algae	An increasing risk to livestock health is likely when cell counts of microcystins exceed 11, 500 cells/mL and/or concentrations of microcystins exceed 2.3 µg/L expressed as microcystin-LR toxicity equivalents.	The quarrying activity is not a source of nitrogen and will not contribute nitrogen to the aquatic ecosystem. Land clearing and stockpiling of topsoil and vegetation may release nutrients to the waterways that may contribute to algal blooms. Rehabilitation activities such as fertilisation of areas to be revegetated may contribute nutrients at levels equivalent to surrounding agricultural practices that may contribute to algal blooms.	Effective. Vegetation and topsoil stockpiles will be suitably stabilised and not located in areas of concentrated flows. Any fertiliser to be applied to rehabilitation areas will be at a rate determined though analysis of growth medium material and requirement of target species to be planted. Rate of release of nitrogen in fertilisers may be limited by using slow-release fertilisers.	Low	Control measures are cost effective and feasible.
	Salinity (electrical conductivity)	Poultry • 0-2,000mg/L Dairy cattle • 0-2,500mg/L TDS Beef cattle, horses, pigs • 0-4,000mg/L TDS Sheep • 0-5,000mg/L TDS (table 4.3.1 -ANZECC 2000 Guidelines).	The quarrying activity is not considered a source of salinity and will not contribute salinity to the aquatic ecosystem.	Effective Erosion and sediment control devices will be installed prior to earthworks and will be designed and operated in accordance with the Blue Book.	Low	Control measures are cost effective and feasible.
	Thermotolerant coliforms (faecal coliforms)	Drinking water for livestock should contain less than 100 thermotolerant coliforms per 100 mL (median value).	The quarrying activity is not a source of thermotolerant coliforms and will not contribute thermotolerant coliforms to the aquatic ecosystem.	No specific management measures proposed.	Low	Not applicable.
	Chemical contaminants	Refer to Table 4.3.2 (ANZECC 2000 Guidelines) for heavy metals and metalloids in livestock drinking water. Refer to Australian Drinking Water Guidelines (NHMRC and NRMMC 2004) for information regarding pesticides and other organic contaminants, using criteria for raw drinking water.	Quarrying activities are unlikely to be a source of chemical contaminants or toxicants. Fuel may be the most likely contaminant.	Effective Only small volumes of fuel are held on site and only during quarrying or rehabilitation activities. No fuel is stored on site and spill kits are available.	Low	Control measures are cost effective and feasible.

9.4.2 Macquarie – Bogan River Water Flow Objectives and Measures to Achieve Objectives

Table 15. Effect Base Assessment of Macquarie – Bogan River Water Flow

Objective	Indicator	Effect of Land Use Activity on Indicator	Effectiveness of Proposed Management Responses	Risk of Impact	Strategic Impact Assessment (feasibility of achieving intended outcomes)
Protect natural water levels in pools of creeks and rivers and wetlands during periods of no flows.	Creek flows.	Quarrying may prevent surface water from returning to the downstream environment.	Effective No water extraction from streams is undertaken. The quarry is located at the headwaters of first order streams and do not experience permanent water flows or contain pools. Surface water retained within sediment dams will be largely returned to the downstream environment, in a timely manner, when discharge water quality criteria are met. Note, some water will be retained to assist with dust mitigation.	Low	Control measures are cost effective and feasible.
Protect natural low flows.	Creek flows.	Quarrying may prevent surface water from returning to the downstream environment.	Effective No water extraction from streams is undertaken. The quarry is located at the headwaters of first order streams and do not experience permanent water flows or contain pools. Surface water retained within sediment dams will be largely returned to the downstream environment, in a timely manner, when discharge water quality criteria are met. Note, some water will be retained to assist with dust mitigation.	Low	Control measures are cost effective and feasible.
Protect or restore a proportion of moderate flows ('freshes') and high flows	Creek flows.	Not applicable. No water is extracted from creeks and will not require restrictions to protect moderate or high flows.	-	-	-
Maintain or restore the natural inundation patterns and distribution of floodwaters supporting natural wetland and floodplain ecosystems	Floodplain or Wetland inundation	Not applicable. The site is not located in or near a floodplain or wetland.	-	-	-
Mimic the natural frequency, duration and seasonal nature of drying periods in naturally temporary waterways	Creek flows	Quarrying may prevent surface water from returning to the downstream environment.	Effective Quarrying will not contribute additional water to the downstream environment. Surface water retained within sediment dams will be largely returned to the downstream environment, in a timely manner, when discharge water quality criteria are met. Note, some water will be retained to assist with dust mitigation.	Low	Control measures are cost effective and feasible.
Maintain or mimic natural flow variability in all streams	Creek flows	Quarrying may prevent surface water from returning to the downstream environment.	Effective Surface water retained within sediment dams will be largely returned to the downstream environment, in a timely manner, when discharge water quality criteria are met. Note, some water will be retained to assist with dust mitigation.	Low	Control measures are cost effective and feasible.

Objective	Indicator	Effect of Land Use Activity on Indicator	Effectiveness of Proposed Management Responses	Risk of Impact	Strategic Impact Assessment (feasibility of achieving intended outcomes)
Maintain rates of rise and fall of river heights within natural bounds	River heights.	Not applicable. The site is not located in or near a river.	-	-	-
Maintain groundwater within natural levels and variability, critical to surface flows and ecosystems	Groundwater levels.	Quarrying is unlikely to change the groundwater levels as it is unlikely to intercept groundwater due to the ridgeline setting. It is not located within any identified Potential Groundwater Dependant Ecosystem.	Effective The quarry depth will be limited to 1055m AHD and is unlikely to intercept groundwater, found to be at approximately 1049m AHD.	Low	Control measures are cost effective and feasible.
Minimise the impact of instream structures	-	Not applicable. No quarrying activities within creeks.	-	-	-
Minimise downstream water quality impacts of storage releases	Discharge water quality.	Discharge of water from the site may impact the quality of water downstream.	Effective Surface water retained within sediment dams will only occur when discharge water quality criteria are met.	Low	Control measures are cost effective and feasible.
Ensure river flow management provides for contingencies	River flows.	Not applicable. The site is not located in or near a river.	-	-	-

10 Monitoring and Maintenance

10.1 SURFACE WATER QUALITY

Samples, if required are collected and tested by a NATA Accredited Facility in accordance with the EPL conditions.

Analytes tested and concentration limits will be those listed in the EPA licence and are expected to be as follows:

- pH is to be between 6.5 to 8.5; and
- TSS is <50mg/L; or
- Turbidity <150 µS/cm.

Monitoring of the surface water outside the EPL Licence Points may be undertaken from time to time such as the other sediment dams in and out of the pit.

The results of all monitoring are recorded to the EPA in the Annual Return.

10.2 CONTAMINATED WATER

- No waste will be stored on-site unless adequately bunded and stored;
- Contractors will remove all waste at the end of each day or ensure it is stored in the appropriate on-site bins for later removal by a licenced contractor;
- Regular visual monitoring will be undertaken to ensure no leaks, spills or other sources of contamination have entered the water management system; and
- Should a spill or leak occur, contractors will proceed as per their Spill and Leaks procedures.

10.3 SURFACE WATER FLOWS

The following management checks on the surface water flows will be undertaken at least quarterly and recorded:

- Visual check of stability and operation of all banks, ponds, channels and spillways, effecting any necessary repairs;
- Visually check the discharge point to ensure that the discharge does not cause erosion or scouring of the creeks. Effecting any necessary repairs;
- Drains and culverts for both clean water and dirty water will be examined for vegetation cover and blockages and maintenance will be performed to ensure they are working as designed;
- Diversion bund walls will be inspected regularly to assess the integrity and effectiveness. Maintenance will be performed when required;
- Removal of spilled materials from hazard areas, including lands closer than five metres from areas of likely concentrated or high velocity flows, especially waterways and access roads;
- Ensuring that rehabilitated lands have effectively reduced the erosion hazard and initiate upgrading or repair as appropriate; and
- Constructing additional erosion and /or sediment control works as might become necessary to ensure the desired water quality control is achieved

10.4 EROSION AND SEDIMENT CONTROLS

Monitoring of the soil erosion, sediment and water is undertaken at least quarterly and recorded.

- Topsoil stripping to be visually monitored to check moisture content of soil and depth of stripping;
- Stockpiles to be visually assessed at time of forming to check they do not exceed two metres high;
- Removal of spilled soil or other materials from hazard areas, including lands closer than five metres from areas of likely concentrated or high velocity flows, especially waterways and access roads;
- Ensuring rehabilitated lands have effectively reduced the erosion hazard and initiate upgrading or repair as appropriate; and
- Constructing additional erosion and/or sediment control works as might become necessary to ensure the desired water control is achieved.

10.5 SEDIMENT DAM MANAGEMENT AND MAINTENANCE

Sediment dams will be managed using the following:

- Level indicators will be installed in dams with relevant marks located on the peg to indicate the amount of sediment load in the dam;
- All sediment basins will be maintained by de-silting when the capacity is diminished;
- Sediment dams and clean water dams will be visually assessed for water quality and volumes on a regular basis or as required after high rainfall events;
- If discharge is required, the visual assessment will be followed by sampling and testing of the water quality prior to discharge to ensure water quality criteria are met;
- The limit of TSS of less than 50mg/L or turbidity less than 150µS/cm in the discharged water will be adopted (unless modified by the EPA);
- Ensuring that rehabilitated lands have effectively reduced the erosion hazard and initiate upgrading or repair as appropriate; and
- Constructing additional erosion and /or sediment control works as might become necessary to ensure the desired water quality control is achieved.

11 Conclusion

The proposed surface water and sediment and erosion controls for the quarry development will result in minimal impacts to the surrounding environment. Surface water collected over the disturbed surfaces can be effectively contained, treated (if required) and discharged back into the downstream environment with very little change to the downstream flows and riparian communities. The quarry is unlikely to intersect groundwater and thus the impact to aquifers and groundwater dependant ecosystems is considered negligible.

A risk assessment based on *Risk Based Framework for Considering Water Health and Outcomes in Strategic Land-use Planning Decisions (OEH & EPA 2017* found that the risks are low and potential impacts can be managed adequately and feasibly.

The water balance suggests that adequate water can be held on site, with the construction of the Clean Water Dam to undertake dust suppression and irrigation of rehabilitation. A Water Access Licence (WAL) will not be required for these activities as the total volume of water proposed to be held on the property is below the Harvestable Rights. The construction of any new dams, however, will require approval from Water NSW.

The final landform will be a vegetated, stable, free draining bowl with the Dams 1 and 2 being retained. This will be compatible with surrounding landuses of forestry and agriculture.

12 References

Ref 1 Borg (2020) *Razorback Quarry Scoping Report*

Ref 2 DECC (2008) Managing Urban Stormwater Soils and Construction V1

Ref 3 DECC (2009) Managing Urban Stormwater Soils and Construction V2E Mines and Quarries

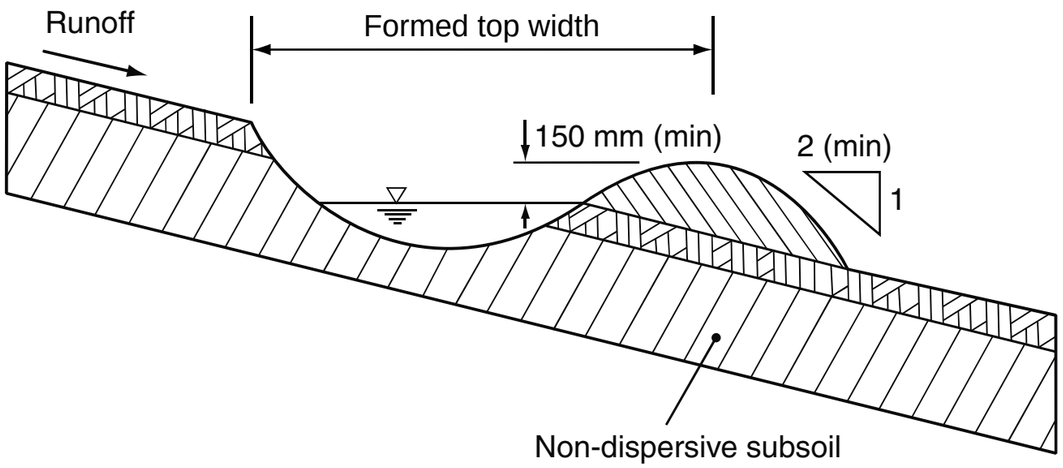
Ref 4 Minter Ellison (2021) *Correspondence- Updated Advice: Razorback Quarry project- BDAR Issues (10/9/2021)*

Ref 5 MJD Environmental (2022) *Biodiversity Assessment- 39 Razorback Road, Running Stream*

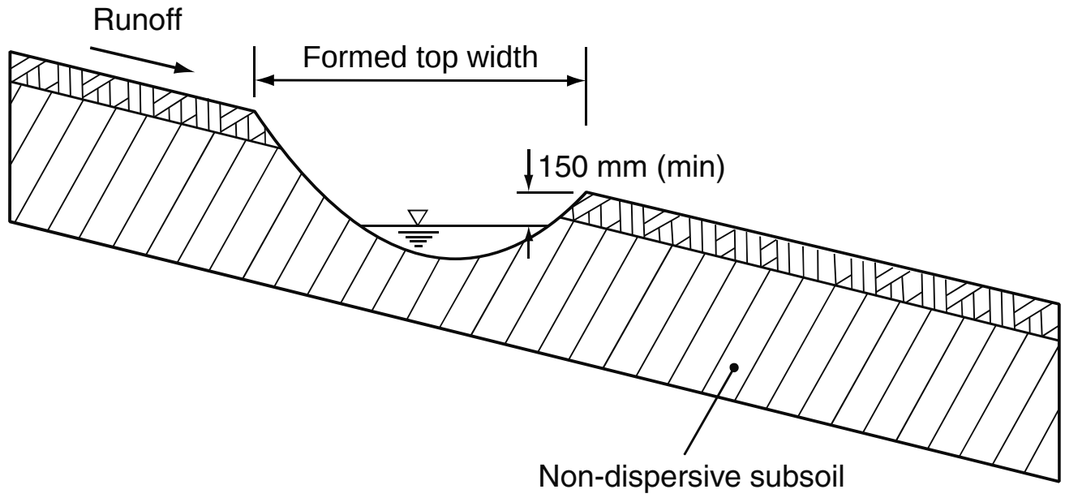
Ref 6 Planning, Industry and Environment (2021) *Planning Secretary's Environmental Assessment Requirements*

Ref 7 VGT Environmental Compliance Solutions Pty Ltd (2020) *Geological Review and Staged Quarry Assessment for Running Stream Quarry.*

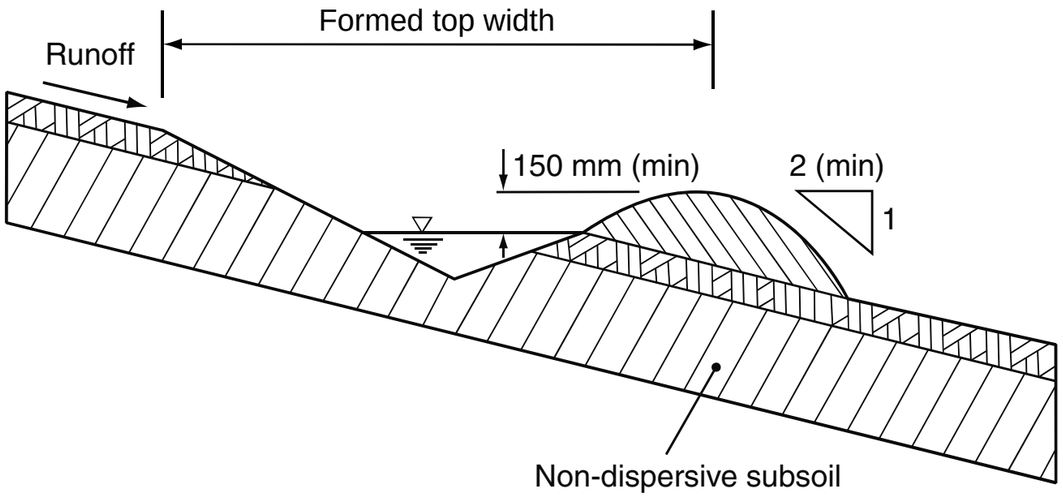
Appendix A
Blue Book Calculations and Standard Drawings



(a) Parabolic catch drain with down-slope bank



(c) Parabolic catch drain without bank



(b) Triangular V-drain with down-slope bank

Constructed dimensions of parabolic catch drains		
Drain type	Formed top width with or without bank	Formed depth with or without bank
Type-A	1.6 m	0.30 m
Type-B	2.4 m	0.45 m
Type-C	3.6 m	0.65 m

Constructed dimensions of triangular V-drains		
Drain type	Formed top width with or without bank	Formed depth with or without bank
Type-AV	2.0 m	0.30 m
Type-BV	2.7 m	0.45 m
Type-CV	3.9 m	0.65 m

NOT TO SCALE

Drawn:	Date:		
GMW	Dec-09	Catch Drains	CD-01

INSTALLATION (EARTH-LINED)

1. REFER TO APPROVED PLANS FOR LOCATION, EXTENT, AND CONSTRUCTION DETAILS. IF THERE ARE QUESTIONS OR PROBLEMS WITH THE LOCATION, EXTENT, OR METHOD OF INSTALLATION, CONTACT THE ENGINEER OR RESPONSIBLE ON-SITE OFFICER FOR ASSISTANCE.

2. CLEAR THE LOCATION FOR THE CATCH DRAIN, CLEARING ONLY WHAT IS NEEDED TO PROVIDE ACCESS FOR PERSONNEL AND EQUIPMENT FOR INSTALLATION.

3. REMOVE ROOTS, STUMPS, AND OTHER DEBRIS AND DISPOSE OF THEM PROPERLY. DO NOT USE DEBRIS TO BUILD THE BANK.

4. GRADE THE DRAIN TO THE SPECIFIED SLOPE AND FORM THE ASSOCIATED EMBANKMENT WITH COMPACTED FILL. NOTE THAT THE DRAIN INVERT MUST FALL 10cm EVERY 10m FOR EACH 1% OF REQUIRED CHANNEL GRADIENT.

5. ENSURE THE SIDES OF THE CUT DRAIN ARE NO STEEPER THAN A 1.5:1 (H:V) SLOPE AND THE EMBANKMENT FILL SLOPES NO STEEPER THAN 2:1.

6. ENSURE THE COMPLETED DRAIN HAS SUFFICIENT DEEP (AS SPECIFIED FOR THE TYPE OF DRAIN) MEASURED FROM THE DRAIN INVERT TO THE TOP OF THE EMBANKMENT.

7. ENSURE THE DRAIN HAS A CONSTANT FALL IN THE DESIRED DIRECTION FREE OF OBSTRUCTIONS.

8. ENSURE THE DRAIN DISCHARGES TO A STABLE OUTLET SUCH THAT SOIL EROSION WILL BE PREVENTED FROM OCCURRING. SPECIFICALLY, ENSURE THE DRAIN DOES NOT DISCHARGE TO AN UNSTABLE FILL SLOPE.

MAINTENANCE

1. INSPECT ALL CATCH DRAINS AT LEAST WEEKLY AND AFTER RUNOFF-PRODUCING STORM EVENTS AND REPAIR ANY SLUMPS, BANK DAMAGE, OR LOSS OF FREEBOARD.

2. ENSURE FILL MATERIAL OR SEDIMENT IS NOT PARTIALLY BLOCKING THE DRAIN. WHERE NECESSARY, REMOVE ANY DEPOSITED MATERIAL TO ALLOW FREE DRAINAGE.

3. DISPOSE OF ANY SEDIMENT OR FILL IN A MANNER THAT WILL NOT CREATE AN EROSION OR POLLUTION HAZARD.

REMOVAL

1. WHEN THE SOIL DISTURBANCE ABOVE THE CATCH DRAIN IS FINISHED AND THE AREA IS STABILISED, THE TEMPORARY DRAIN AND ANY ASSOCIATED BANKS SHOULD BE REMOVED, UNLESS IT IS TO REMAIN AS A PERMANENT DRAINAGE FEATURE.

2. DISPOSE OF ANY SEDIMENT OR EARTH IN A MANNER THAT WILL NOT CREATE AN EROSION OR POLLUTION HAZARD.

3. GRADE THE AREA AND SMOOTH IT OUT IN PREPARATION FOR STABILISATION.

4. STABILISE THE AREA BY GRASSING OR AS SPECIFIED WITHIN THE APPROVED SITE REHABILITATION PLAN.

Drawn:	Date:		
GMW	Dec-09	Catch Drains - Earth Lined	CD-02

INSTALLATION

1. REFER TO APPROVED PLANS FOR LOCATION, EXTENT, AND CONSTRUCTION DETAILS. IF THERE ARE QUESTIONS OR PROBLEMS WITH THE LOCATION, EXTENT, OR METHOD OF INSTALLATION, CONTACT THE ENGINEER OR RESPONSIBLE ON-SITE OFFICER FOR ASSISTANCE.

2. ENSURE ALL NECESSARY SOIL TESTING (e.g. SOIL pH, NUTRIENT LEVELS) AND ANALYSIS HAS BEEN COMPLETED, AND REQUIRED SOIL ADJUSTMENTS PERFORMED PRIOR TO PLANTING.

3. CLEAR THE LOCATION FOR THE CATCH DRAIN, CLEARING ONLY WHAT IS NEEDED TO PROVIDE ACCESS FOR PERSONNEL AND EQUIPMENT FOR INSTALLATION.

4. REMOVE ROOTS, STUMPS, AND OTHER DEBRIS AND DISPOSE OF THEM PROPERLY. DO NOT USE DEBRIS TO BUILD THE BANK.

5. GRADE THE DRAIN TO THE SPECIFIED SLOPE AND FORM THE ASSOCIATED EMBANKMENT WITH COMPACTED FILL. NOTE THAT THE DRAIN INVERT MUST FALL 10cm EVERY 10m FOR EACH 1% OF CHANNEL GRADIENT.

6. ENSURE THE SIDES OF THE CUT DRAIN ARE NO STEEPER THAN A 1.5:1 (H:V) SLOPE AND THE EMBANKMENT FILL SLOPES NO STEEPER THAN 2:1.

7. ENSURE THE COMPLETED DRAIN HAS SUFFICIENT DEEP (AS SPECIFIED FOR THE TYPE OF DRAIN) MEASURED FROM THE DRAIN INVERT TO THE TOP OF THE EMBANKMENT. WHERE NECESSARY, CUT THE DRAIN SLIGHTLY DEEPER THAN THAT SPECIFIED ON THE PLANS SUCH THAT THE CORRECT CHANNEL DIMENSIONS ARE ACHIEVED FOLLOWING PLACEMENT OF THE TURF.

8. ENSURE THE DRAIN HAS A CONSTANT FALL IN THE DESIRED DIRECTION FREE OF OBSTRUCTIONS.

9. TURF SHOULD BE USED WITHIN 12-HOURS OF DELIVERY, OTHERWISE ENSURE THE TURF IS STORED IN CONDITIONS APPROPRIATE FOR THE WEATHER CONDITIONS (e.g. A SHADED AREA).

10. MOISTENING THE TURF AFTER IT IS UNROLLED WILL HELP MAINTAIN ITS VIABILITY.

11. TURF SHOULD BE LAID ON A MINIMUM 75mm BED OF ADEQUATELY FERTILISED TOPSOIL. RAKE THE SOIL SURFACE TO BREAK THE CRUST JUST BEFORE LAYING THE TURF.

12. DURING THE WARMER MONTHS, LIGHTLY IRRIGATE THE SOIL IMMEDIATELY BEFORE LAYING THE TURF.

13. ENSURE THE TURF IS NOT LAID ON GRAVEL, HEAVILY COMPACTED SOILS, OR SOILS THAT HAVE BEEN RECENTLY TREATED WITH HERBICIDES.

14. FOR WIDE DRAINS AND HIGH VELOCITY CHUTES, LAY THE FIRST ROW OF TURF IN A STRAIGHT LINE DIAGONAL TO THE DIRECTION OF FLOW. STAGGER SUBSEQUENT ROWS IN A BRICK-LIKE (STRETCHER BOND) PATTERN. THE TURF SHOULD NOT BE STRETCHED OR OVERLAPPED. USE A KNIFE OR SHARP SPADE TO TRIM AND FIT IRREGULARLY SHAPED AREAS.

15. FOR NARROW DRAINS, LAY THE TURF ALONG THE DIRECTION OF THE DRAIN, ENSURING, WHEREVER PRACTICABLE, THAT A LONGITUDINAL JOINT BETWEEN TWO STRIPS OF TURF IS NOT POSITIONED ALONG THE INVERT OF THE DRAIN.

16. ENSURE THE TURF EXTENDS UP THE SIDES OF THE DRAIN AT LEAST 100mm ABOVE THE ELEVATION OF THE CHANNEL INVERT, OR AT LEAST TO A SUFFICIENT ELEVATION TO FULLY CONTAIN EXPECTED CHANNEL FLOW.

17. ON CHANNEL GRADIENTS OF 3:1(H:V) OR STEEPER, OR IN SITUATIONS WHERE HIGH FLOW VELOCITIES (i.e. VELOCITY >1.5m/s) ARE LIKELY WITHIN THE FIRST 2-WEEKS FOLLOWING PLACEMENT, SECURE THE INDIVIDUAL TURF STRIPS WITH WOODEN OR PLASTIC PEGS.

18. ENSURE THAT INTIMATE CONTACT IS ACHIEVED AND MAINTAINED BETWEEN THE TURF AND THE SOIL SUCH THAT SEEPAGE FLOW BENEATH THE TURF IS AVOIDED.

19. WATER UNTIL THE SOIL IS WET 100mm BELOW THE TURF. THEREAFTER, WATERING SHOULD BE SUFFICIENT TO MAINTAIN AND PROMOTE HEALTHY GROWTH.

20. ENSURE THE DRAIN DISCHARGES TO A STABLE OUTLET SUCH THAT DOWN-SLOPE SOIL EROSION WILL BE PREVENTED FROM OCCURRING. ENSURE THE DRAIN DOES NOT DISCHARGE TO AN UNSTABLE FILL SLOPE.

MAINTENANCE

1. INSPECT ALL CATCH DRAINS AT LEAST WEEKLY AND AFTER RUNOFF-PRODUCING STORM EVENTS AND REPAIR ANY SLUMPS, BANK DAMAGE, OR LOSS OF FREEBOARD.

2. ENSURE FILL MATERIAL OR SEDIMENT IS NOT PARTIALLY BLOCKING THE DRAIN. WHERE NECESSARY, REMOVE ANY DEPOSITED MATERIAL TO ALLOW FREE DRAINAGE.

3. DISPOSE OF ANY SEDIMENT OR FILL IN A MANNER THAT WILL NOT CREATE AN EROSION OR POLLUTION HAZARD.

REMOVAL

1. WHEN THE SOIL DISTURBANCE ABOVE THE CATCH DRAIN IS FINISHED AND THE AREA IS STABILISED, THE DRAIN AND ANY ASSOCIATED BANKS SHOULD BE REMOVED, UNLESS IT IS TO REMAIN AS A PERMANENT DRAINAGE FEATURE.

2. DISPOSE OF ANY SEDIMENT OR EARTH IN A MANNER THAT WILL NOT CREATE AN EROSION OR POLLUTION HAZARD.

3. GRADE THE AREA AND SMOOTH IT OUT IN PREPARATION FOR STABILISATION.

4. STABILISE THE AREA BY GRASSING OR AS SPECIFIED WITHIN THE APPROVED PLAN.

Drawn:	Date:		
GMW	Dec-09	Catch Drains - Grass Lined	CD-03

INSTALLATION (DRAIN FORMATION)

1. REFER TO APPROVED PLANS FOR LOCATION, EXTENT, AND CONSTRUCTION DETAILS. IF THERE ARE QUESTIONS OR PROBLEMS WITH THE LOCATION, EXTENT, OR METHOD OF INSTALLATION, CONTACT THE ENGINEER OR RESPONSIBLE ON-SITE OFFICER FOR ASSISTANCE.

2. CLEAR THE LOCATION FOR THE CATCH DRAIN, CLEARING ONLY WHAT IS NEEDED TO PROVIDE ACCESS FOR PERSONNEL AND EQUIPMENT FOR INSTALLATION.

3. REMOVE ROOTS, STUMPS, AND OTHER DEBRIS AND DISPOSE OF THEM PROPERLY. DO NOT USE DEBRIS TO BUILD THE BANK.

4. GRADE THE DRAIN TO THE SPECIFIED SLOPE AND FORM THE ASSOCIATED EMBANKMENT WITH COMPACTED FILL. NOTE THAT THE DRAIN INVERT MUST FALL 10cm EVERY 10m FOR EACH 1% OF CHANNEL GRADIENT.

5. ENSURE THE SIDES OF THE CUT DRAIN ARE NO STEEPER THAN A 1.5:1 (H:V) SLOPE AND THE EMBANKMENT FILL SLOPES NO STEEPER THAN 2:1.

6. ENSURE THE COMPLETED DRAIN HAS SUFFICIENT DEEP (AS SPECIFIED FOR THE TYPE OF DRAIN) MEASURED FROM THE DRAIN INVERT TO THE TOP OF THE EMBANKMENT.

7. ENSURE THE DRAIN HAS A CONSTANT FALL IN THE DESIRED DIRECTION FREE OF OBSTRUCTIONS.

8. ENSURE THE DRAIN DISCHARGES TO A STABLE OUTLET SUCH THAT SOIL EROSION WILL BE PREVENTED FROM OCCURRING. ENSURE THE DRAIN DOES NOT DISCHARGE TO AN UNSTABLE FILL SLOPE.

INSTALLATION (MAT PLACEMENT)

THE METHOD OF MAT INSTALLATION VARIES WITH THE TYPE OF MAT. INSTALLATION PROCEDURES SHOULD BE PROVIDED BY THE MANUFACTURER OR DISTRIBUTOR OF THE PRODUCT. A TYPICAL INSTALLATION PROCEDURE IS DESCRIBED BELOW, BUT SHOULD BE CONFIRMED WITH THE PRODUCT MANUFACTURER OR DISTRIBUTOR.

1. EROSION CONTROL MATS MUST BE STORED AWAY FROM DIRECT SUNLIGHT OR COVERED WITH ULTRAVIOLET LIGHT PROTECTIVE SHEETING UNTIL THE SITE IS READY FOR THEIR INSTALLATION.

2. VEHICLES AND CONSTRUCTION EQUIPMENT MUST NOT BE PERMITTED TO MANOEUVRE OVER THE GEOTEXTILE UNLESS IT HAS BEEN COVERED WITH A LAYER OF SOIL OR GRAVEL AT LEAST 150mm THICK. FILL MATERIAL SHALL NOT BE MIXED OVER THE GEOTEXTILE.

3. IF THE CHANNEL IS TO BE GRASSED, PREPARE A SMOOTH SEED BED OF APPROXIMATELY 75mm OF TOPSOIL, SEED, FERTILISE, WATER AND RAKE TO REMOVE ANY REMAINING SURFACE IRREGULARITIES.

4. EXCAVATE A 300mm DEEP BY 150mm WIDE ANCHOR TRENCH ALONG THE FULL WIDTH OF THE UPSTREAM END OF THE AREA TO BE TREATED.

5. AT LEAST 300mm OF THE MAT MUST BE ANCHORED INTO THE TRENCH WITH THE ROLL OF MATTING RESTING ON THE GROUND UP-SLOPE OF THE TRENCH.

6. STAPLE THE FABRIC WITHIN THE TRENCH AT 200 TO 250mm SPACING USING 100mm WIDE BY 150mm PENETRATION LENGTH U-SHAPED, 8 TO 11 GAUGE WIRE STAPLES. NARROWER U-SECTIONS MAY EASILY TEAR THE MATTING WHEN PLACED UNDER STRESS.

7. WHEN ALL MATS HAVE BEEN ANCHORED WITHIN THE TRENCH ACROSS THE FULL WIDTH OF THE TREATED AREA, THEN THE TRENCH IS BACKFILLED AND COMPACTED. THE MATS ARE THEN UNROLLED DOWN THE SLOPE SUCH THAT EACH MAT COVERS AND PROTECTS THE BACKFILLED TRENCH.

8. WHEN SPREADING THE MATS, AVOID STRETCHING THE FABRIC. THE MATS SHOULD REMAIN IN GOOD CONTACT WITH THE SOIL.

9. IF THE CHANNEL CURVES, THEN SUITABLY FOLD (IN A DOWNSTREAM DIRECTION) AND STAPLE THE FABRIC TO MAINTAIN THE FABRIC PARALLEL TO THE DIRECTION OF CHANNEL FLOW.

10. STAPLE THE SURFACE OF THE MATTING AT 1m CENTRES. ON IRREGULAR GROUND, ADDITIONAL STAPLES WILL BE REQUIRED WHEREVER THE MAT DOES NOT INITIALLY CONTACT THE GROUND SURFACE.

11. AT THE END OF EACH LENGTH OF MAT, A NEW TRENCH IS FORMED AT LEAST 300mm UP-SLOPE OF THE END OF THE MAT SUCH THAT THE END OF THE MAT WILL BE ABLE TO FULLY COVER THE TRENCH. A NEW ROLL OF MATTING IS THEN ANCHORED WITHIN THIS TRENCH AS PER THE FIRST MAT. AFTER THIS NEW MAT HAS BEEN UNROLLED DOWN THE SLOPE, THE UP-SLOPE MAT CAN BE PINNED IN PLACE FULLY COVERING THE NEW TRENCH AND AT LEAST 300mm OF THE DOWN-SLOPE MAT. THE PROCESS IS CONTINUED DOWN THE SLOPE UNTIL THE DESIRED AREA IS FULLY COVERED.

12. IN HIGH-VELOCITY CHANNELS, INTERMEDIATE ANCHOR SLOTS ARE USUALLY REQUIRED AT 10M INTERVALS DOWN THE CHANNEL.

13. ANCHOR THE OUTER MOST EDGES (TOP AND UPPER MOST SIDES) OF THE TREATED AREA IN A 300mm DEEP TRENCH AND STAPLE AT 200 TO 250mm CENTRES.

14. IF THE CHANNEL WAS GRASS SEEDED PRIOR TO PLACEMENT OF THE MATS, THEN THE MATS SHOULD BE ROLLED WITH A SUITABLE ROLLER WEIGHING 60 TO 90kg/m, THEN WATERED.

15. THE INSTALLATION PROCEDURE MUST ENSURE THAT THE MAT ACHIEVES AND RETAINS GOOD CONTACT WITH THE SOIL.

16. DAMAGED MATTING MUST BE REPAIRED OR REPLACED.

ADDITIONAL INSTRUCTIONS FOR THE INSTALLATION OF JUTE MESH (NOT JUTE BLANKETS):

1. ENSURE THE JUTE MESH IS LAID ON A FIRM EARTH SURFACE THAT HAS BEEN TRIMMED, TOPSOILED, WATERED, SOWN WITH SEED AND FERTILISER.

2. THE JUTE MESH IS THEN EITHER TAMPED OR ROLLED FIRMLY ONTO THE PREPARED SURFACE, AVOIDING STRETCHING, WATERED TO ENCOURAGE THE PENETRATION OF THE BITUMEN EMULSION, AND FINALLY SPRAYED WITH A TOP LAYER OF BITUMEN AT 1 TO 3 LITRES PER SQUARE METRE.

3. THE RATE OF EMULSION APPLICATION SHOULD BE ADJUSTED SUCH THAT THE EMULSION JUST STARTS TO POND IN THE MESH SQUARES.

MAINTENANCE

1. INSPECT ALL CATCH DRAINS AT LEAST WEEKLY AND AFTER RUNOFF-PRODUCING STORM EVENTS AND REPAIR ANY SLUMPS, BANK DAMAGE, OR LOSS OF FREEBOARD.

2. ENSURE FILL MATERIAL OR SEDIMENT IS NOT PARTIALLY BLOCKING THE DRAIN. WHERE NECESSARY, REMOVE ANY DEPOSITED MATERIAL TO ALLOW FREE DRAINAGE.

3. DISPOSE OF ANY SEDIMENT OR FILL IN A MANNER THAT WILL NOT CREATE AN EROSION OR POLLUTION HAZARD.

REMOVAL

1. WHEN THE SOIL DISTURBANCE ABOVE THE CATCH DRAIN IS FINISHED AND THE AREA IS STABILISED, THE DRAIN AND ANY ASSOCIATED BANKS SHOULD BE REMOVED, UNLESS IT IS TO REMAIN AS A PERMANENT DRAINAGE FEATURE.

2. DISPOSE OF ANY SEDIMENT OR EARTH IN A MANNER THAT WILL NOT CREATE AN EROSION OR POLLUTION HAZARD.

3. GRADE THE AREA AND SMOOTH IT OUT IN PREPARATION FOR STABILISATION.

4. STABILISE THE AREA BY GRASSING OR AS SPECIFIED WITHIN THE APPROVED PLAN.

Drawn:	Date:		
GMW	May-10	Catch Drains - Geotextile Lined	CD-04

MATERIALS

ROCK:
(i) ALL ROCK MUST BE HARD, WEATHER RESISTANT, AND DURABLE AGAINST DISINTEGRATION UNDER CONDITIONS TO BE MET IN HANDLING, PLACEMENT AND OPERATION.

(ii) ALL ROCK MUST HAVE ITS GREATEST DIMENSION NOT GREATER THAN 3 TIMES ITS LEAST DIMENSIONS.

(iii) THE ROCK USED IN FORMATION OF THE DRAIN MUST BE EVENLY GRADED WITH 50% BY WEIGHT LARGER THAN THE SPECIFIED NOMINAL ROCK SIZE AND HAVE SUFFICIENT SMALL ROCK TO FILL THE VOIDS BETWEEN THE LARGER ROCK. DIRT, FINES, AND SMALLER ROCK MUST NOT EXCEED 5% BY WEIGHT.

(iv) THE DIAMETER OF THE LARGEST ROCK SIZE SHOULD BE NO LARGER THAN 1.5 TIMES THE NOMINAL ROCK SIZE. SPECIFIC GRAVITY TO BE AT LEAST 2.5.

(v) THE COLOUR OF THE RIPRAP SHALL BE [INSERT] AND MUST BE APPROVED BY THE ENGINEER. ONCE APPROVED, THE COLOUR SHALL BE KEPT CONSISTENT THROUGH THE PROJECT.

GEOTEXTILE FABRIC: HEAVY-DUTY, NEEDLE-PUNCHED, NON-WOVEN FILTER CLOTH, MINIMUM BIDIM A24 OR EQUIVALENT.

INSTALLATION

1. REFER TO APPROVED PLANS FOR LOCATION, EXTENT, AND CONSTRUCTION DETAILS. IF THERE ARE QUESTIONS OR PROBLEMS WITH THE LOCATION, EXTENT, OR METHOD OF INSTALLATION, CONTACT THE ENGINEER OR RESPONSIBLE ON-SITE OFFICER FOR ASSISTANCE.

2. PRIOR TO PLACEMENT, ALL ROCKS MUST BE VISUALLY CHECKED FOR SIZE, ELONGATION, CRACKS, DETERIORATION AND OTHER VISIBLE. THE DEGREE AND THOROUGHNESS OF SUCH CHECKING MUST BE APPROPRIATE FOR THE POTENTIAL CONSEQUENCES ASSOCIATED WITH FAILURE OF THE STRUCTURE OR PURPOSE FOR WHICH THE MATERIAL WILL BE USED.

3. CLEAR THE LOCATION FOR THE CATCH DRAIN, CLEARING ONLY WHAT IS NEEDED TO PROVIDE ACCESS FOR PERSONNEL AND EQUIPMENT FOR INSTALLATION.

4. REMOVE ROOTS, STUMPS, AND OTHER DEBRIS AND DISPOSE OF THEM PROPERLY. DO NOT USE DEBRIS TO BUILD THE BANK.

5. REMOVE ALL SOFT, YIELDING MATERIAL; REPLACE WITH SUITABLE ON-SITE MATERIAL; COMPACT TO SMOOTH FIRM SURFACE.

6. EXCAVATE THE DRAIN TO THE LINES AND GRADES SHOWN ON THE APPROVED PLANS. OVER-CUT THE DRAIN TO A DEPTH EQUAL TO THE SPECIFIED DEPTH OF ROCK PLACEMENT SUCH THAT THE FINISHED TOP SURFACE WILL BE AT THE ELEVATION OF THE SURROUNDING LAND. PLACEMENT OF THE ROCK LINING MUST NOT REDUCE THE DRAIN'S TOP WIDTH AND DEPTH AS SPECIFIED WITHIN THE APPROVED PLANS.

7. GRADE THE DRAIN TO THE SPECIFIED SLOPE AND FORM THE ASSOCIATED EMBANKMENT WITH COMPACTED FILL. NOTE THAT THE DRAIN INVERT MUST FALL 10CM EVERY 10m FOR EACH 1% OF CHANNEL GRADIENT.

8. ENSURE THE SIDES OF THE CUT DRAIN ARE NO STEEPER THAN A 1.5:1 (H:V) SLOPE AND THE EMBANKMENT FILL SLOPES NO STEEPER THAN 2:1.

9. IF THE DRAIN IS CUT INTO A DISPERSIVE (SODIC) SOIL, THEN PRIOR TO PLACING FILTER CLOTH, THE EXPOSED DISPERSIVE SOIL MUST BE COVERED WITH A MINIMUM 200mm THICK LAYER OF NON-DISPERSIVE SOIL PRIOR TO PLACEMENT OF FILTER CLOTH OR ROCKS.

10. IF A FILTER CLOTH UNDERLAY IS SPECIFIED, PLACE THE FILTER FABRIC DIRECTLY ON THE PREPARED FOUNDATION. IF MORE THAN ONE SHEET OF FILTER CLOTH IS REQUIRED TO OVER THE AREA, OVERLAP THE EDGE OF EACH SHEET AT LEAST 300mm, AND SECURE ANCHOR PINS AT MINIMUM 1M SPACING ALONG THE OVERLAP.

11. ENSURE THE FILTER CLOTH IS PROTECTED FROM PUNCHING OR TEARING DURING INSTALLATION OF THE FABRIC AND THE ROCK. REPAIR ANY DAMAGE BY REMOVING THE ROCK AND PLACING WITH ANOTHER PIECE OF FILTER CLOTH OVER THE DAMAGED AREA OVERLAPPING THE EXISTING FABRIC A MINIMUM OF 300mm.

12. PLACEMENT OF ROCK SHOULD FOLLOW IMMEDIATELY AFTER PLACEMENT OF THE FILTER LAYER. PLACE ROCK SO THAT IT FORMS A DENSE, WELL-GRADED MASS OF ROCK WITH A MINIMUM OF VOIDS.

13. PLACE ROCK LINING TO THE EXTENT AND DEPTH INDICATED WITHIN THE APPROVED PLANS.

14. ENSURE THE ROCK IS PLACED IN AN APPROPRIATE MANNER TO AVOID DISPLACING UNDERLYING MATERIALS OR PLACING UNDUE IMPACT FORCE ON THE BEDDING MATERIALS.

15. ENSURE THE ROCK IS PLACED WITH A MINIMUM THICKNESS OF 1.5 TIMES THE NOMINAL ROCK SIZE (D50).

16. ENSURE MATERIALS THAT ARE D50 AND LARGER ARE POSITIONED FLUSH WITH THE TOP SURFACE WITH FACES AND SHAPES MATCHED TO MINIMISE VOIDS.

17. ENSURE PROJECTIONS ABOVE OR DEPRESSIONS UNDER THE SPECIFIED TOP SURFACE ARE LESS THAN 20% OF THE ROCK LAYER THICKNESS. THE AVERAGE SURFACE PLANE OF THE FINISHED ROCK IS DEFINED AS THE PLANE WHERE 50% OF THE TOPS OF ROCKS WOULD CONTACT.

18. ENSURE THE COMPLETED DRAIN HAS SUFFICIENT DEEP (AS SPECIFIED FOR THE TYPE OF DRAIN) MEASURED FROM THE DRAIN INVERT (AVERAGE SURFACE PLANE ALONG CHANNEL INVERT) TO THE TOP OF THE EMBANKMENT. THE AVERAGE SURFACE PLANE OF THE FINISHED ROCK IS DEFINED AS THE PLANE WHERE 50% OF THE TOPS OF ROCKS WOULD CONTACT.

19. TO THE MAXIMUM DEGREE PRACTICABLE, THE MATERIAL BETWEEN LARGER ROCK MUST NOT BE LOOSE OR EASILY DISPLACED BY THE EXPECTED FLOW.

20. AFTER PLACEMENT OF THE ROCK LINING, ENSURE THE DRAIN HAS A CONSTANT FALL IN THE DESIRED DIRECTION FREE OF OBSTRUCTIONS.

21. ENSURE THE DRAIN DISCHARGES TO A STABLE OUTLET SUCH THAT SOIL EROSION WILL BE PREVENTED FROM OCCURRING. ENSURE THE DRAIN DOES NOT DISCHARGE TO AN UNSTABLE FILL SLOPE.

MAINTENANCE

1. INSPECT ALL CATCH DRAINS AT LEAST WEEKLY AND AFTER RUNOFF-PRODUCING STORM EVENTS AND REPAIR ANY SLUMPS, BANK DAMAGE, OR LOSS OF FREEBOARD.

2. CLOSELY INSPECT THE OUTER EDGES OF THE ROCK PROTECTION. ENSURE WATER ENTRY INTO THE ROCK-LINED AREA IS NOT CAUSING EROSION ALONG THE EDGE OF THE ROCK PROTECTION.

3. CAREFULLY CHECK THE STABILITY OF THE ROCK LOOKING FOR INDICATIONS OF PIPING, SCOUR HOLES, OR BANK FAILURES.

4. REPLACE OR REPOSITION THE SURFACE ROCK SUCH THAT THE DRAIN FUNCTIONS AS REQUIRED AND THE DRAIN'S REQUIRED HYDRAULIC CAPACITY IS NOT REDUCED.

5. REPLACE ANY DISPLACED ROCK WITH ROCK OF A SIGNIFICANTLY (MINIMUM 110%) LARGER SIZE THAN THE DISPLACED ROCK.

6. ENSURE SEDIMENT IS NOT PARTIALLY BLOCKING THE DRAIN. WHERE NECESSARY, REMOVE ANY DEPOSITED MATERIAL TO ALLOW FREE DRAINAGE.

7. DISPOSE OF ANY SEDIMENT OR FILL IN A MANNER THAT WILL NOT CREATE AN EROSION OR POLLUTION HAZARD.

Drawn:	Date:		
GMW	Dec-09	Catch Drains - Rock Lined	CD-05

INSTALLATION

1. REFER TO APPROVED PLANS FOR LOCATION, EXTENT, AND CONSTRUCTION DETAILS. IF THERE ARE QUESTIONS OR PROBLEMS WITH THE LOCATION, EXTENT, OR METHOD OF INSTALLATION, CONTACT THE ENGINEER OR RESPONSIBLE ON-SITE OFFICER FOR ASSISTANCE.

2. ENSURE ALL NECESSARY SOIL TESTING (e.g. SOIL pH, NUTRIENT LEVELS) AND ANALYSIS HAS BEEN COMPLETED, AND REQUIRED SOIL ADJUSTMENTS PERFORMED PRIOR TO PLANTING.

3. CLEAR THE LOCATION FOR THE CHANNEL, CLEARING ONLY WHAT IS NEEDED TO PROVIDE ACCESS FOR PERSONNEL AND CONSTRUCTION EQUIPMENT.

4. REMOVE ROOTS, STUMPS, AND OTHER DEBRIS AND DISPOSE OF THEM PROPERLY. DO NOT USE DEBRIS TO BUILD ANY ASSOCIATED EMBANKMENTS.

5. EXCAVATE THE DIVERSION CHANNEL TO THE SPECIFIED SHAPE, ELEVATION AND GRADIENT. THE SIDES OF THE CHANNEL SHOULD BE NO STEEPER THAN A 2:1 (H:V) IF CONSTRUCTED IN EARTH, UNLESS SPECIFICALLY DIRECTED WITHIN THE APPROVED PLANS.

6. STABILISE THE CHANNEL AND BANKS IMMEDIATELY UNLESS IT WILL OPERATE FOR LESS THAN 30 DAYS. IN EITHER CASE, TEMPORARY EROSION PROTECTION (MATTING, ROCK, ETC.) WILL BE REQUIRED AS SPECIFIED WITHIN THE APPROVED PLANS OR AS DIRECTED.

7. ENSURE THE CHANNEL DISCHARGES TO A STABLE AREA.

ADDITIONAL REQUIREMENTS FOR TURF PLACEMENT:

1. TURF SHOULD BE USED WITHIN 12 HOURS OF DELIVERY, OTHERWISE ENSURE THE TURF IS STORED IN CONDITIONS APPROPRIATE FOR THE WEATHER CONDITIONS (e.g. A SHADED AREA).

2. MOISTENING THE TURF AFTER IT IS UNROLLED WILL HELP MAINTAIN ITS VIABILITY.

3. TURF SHOULD BE LAID ON A MINIMUM 75mm BED OF ADEQUATELY FERTILISED TOPSOIL. RAKE THE SOIL SURFACE TO BREAK THE CRUST JUST BEFORE LAYING THE TURF.

4. DURING THE WARMER MONTHS, LIGHTLY IRRIGATE THE SOIL IMMEDIATELY BEFORE LAYING THE TURF.

5. ENSURE THE TURF IS NOT LAID ON GRAVEL, HEAVILY COMPACTED SOILS, OR SOILS THAT HAVE BEEN RECENTLY TREATED WITH HERBICIDES.

6. ENSURE THE TURF EXTENDS UP THE SIDES OF THE DRAIN AT LEAST 100mm ABOVE THE ELEVATION OF THE CHANNEL INVERT, OR AT LEAST TO A SUFFICIENT ELEVATION TO FULLY CONTAIN EXPECTED CHANNEL FLOW.

7. ON CHANNEL GRADIENTS OF 3:1(H:V) OR STEEPER, OR IN SITUATIONS WHERE HIGH FLOW VELOCITIES (i.e. VELOCITY >1.5m/s) ARE LIKELY WITHIN THE FIRST TWO WEEK FOLLOWING PLACEMENT, SECURE THE INDIVIDUAL TURF STRIPS WITH WOODEN OR PLASTIC PEGS.

8. ENSURE THAT INTIMATE CONTACT IS ACHIEVED AND MAINTAINED BETWEEN THE TURF AND THE SOIL SUCH THAT SEEPAGE FLOW BENEATH THE TURF IS AVOIDED.

9. WATER UNTIL THE SOIL IS WET 100mm BELOW THE TURF. THEREAFTER, WATERING SHOULD BE SUFFICIENT TO MAINTAIN AND PROMOTE HEALTHY GROWTH

MAINTENANCE

1. DURING THE SITE'S CONSTRUCTION PERIOD, INSPECT THE DIVERSION CHANNEL WEEKLY AND AFTER ANY INCREASE IN FLOWS WITHIN THE CHANNEL. REPAIR ANY SLUMPS, WHEEL TRACK DAMAGE OR LOSS OF FREEBOARD.

2. ENSURE FILL MATERIAL OR SEDIMENT IS NOT PARTIALLY BLOCKING THE CHANNEL. WHERE NECESSARY, REMOVE ANY DEPOSITED MATERIAL TO ALLOW FREE DRAINAGE.

3. DISPOSE OF ANY COLLECTED SEDIMENT OR FILL IN A MANNER THAT WILL NOT CREATE AN EROSION OR POLLUTION HAZARD.

REMOVAL

1. WHEN THE CONSTRUCTION WORK ABOVE A TEMPORARY DIVERSION CHANNEL IS FINISHED AND THE AREA IS STABILISED, THE AREA SHOULD BE APPROPRIATELY REHABILITATED.

2. DISPOSE OF ANY COLLECTED SEDIMENT OR FILL IN A MANNER THAT WILL NOT CREATE AN EROSION OR POLLUTION HAZARD.

3. GRADE THE AREA AND SMOOTH IT OUT IN PREPARATION FOR STABILISATION.

4. STABILISE THE AREA AS SPECIFIED IN THE APPROVED PLAN.

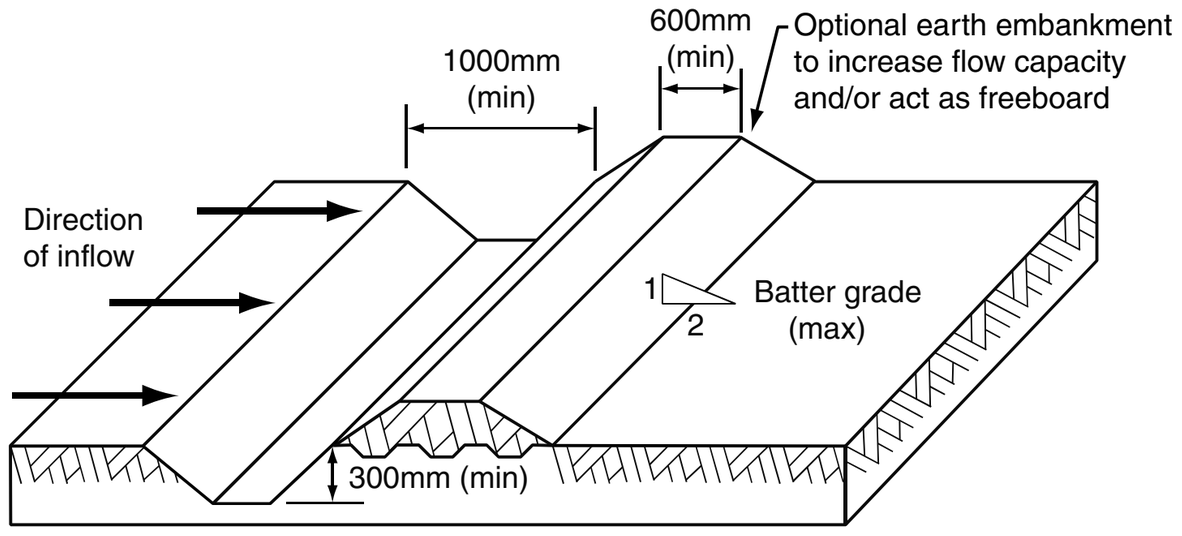


Figure 1 - Typical profile of diversion channel with bank

Drawn:	Date:		
GMW	Dec-09	Diversion Channels	DC-01

CONSTRUCTION

1. THE SPILLWAY MUST BE EXCAVATED AS SHOWN ON THE PLANS, AND THE EXCAVATED MATERIAL IF CLASSIFIED AS SUITABLE, MUST BE USED IN THE EMBANKMENT, AND IF NOT SUITABLE IT MUST BE DISPOSED OF INTO SPOIL HEAPS.

2. ENSURE EXCAVATED DIMENSIONS ALLOW ADEQUATE BOXING-OUT SUCH THAT THE SPECIFIED ELEVATIONS, GRADES, CHUTE WIDTH, AND ENTRANCE AND EXIT SLOPES FOR THE EMERGENCY SPILLWAY WILL BE ACHIEVED AFTER PLACEMENT OF THE ROCK OR OTHER SCOUR PROTECTION MEASURES AS SPECIFIED IN THE PLANS.

3. PLACE SPECIFIED SCOUR PROTECTION MEASURES ON THE EMERGENCY SPILLWAY. ENSURE THE FINISHED GRADE BLENDS WITH THE SURROUNDING AREA TO ALLOW A SMOOTH FLOW TRANSITION FROM SPILLWAY TO DOWNSTREAM CHANNEL.

4. IF A SYNTHETIC FILTER FABRIC UNDERLAY IS SPECIFIED, PLACE THE FILTER FABRIC DIRECTLY ON THE PREPARED FOUNDATION. IF MORE THAN 1 SHEET OF FILTER FABRIC IS REQUIRED, OVERLAP THE EDGES BY AT LEAST 300mm AND PLACE ANCHOR PINS AT MINIMUM 1m SPACING ALONG THE OVERLAP. BURY THE UPSTREAM END OF THE FABRIC A MINIMUM 300mm BELOW GROUND AND WHERE NECESSARY, BURY THE LOWER END OF THE FABRIC OR OVERLAP A MINIMUM 300mm OVER THE NEXT DOWNSTREAM SECTION AS REQUIRED. ENSURE THE FILTER FABRIC EXTENDS AT LEAST 1000mm UPSTREAM OF THE SPILLWAY CREST.

5. TAKE CARE NOT TO DAMAGE THE FABRIC DURING OR AFTER PLACEMENT. IF DAMAGE OCCURS, REMOVE THE ROCK AND REPAIR THE SHEET BY ADDING ANOTHER LAYER OF FABRIC WITH A MINIMUM OVERLAP OF 300mm AROUND THE DAMAGED AREA. IF EXTENSIVE DAMAGE IS SUSPECTED, REMOVE AND REPLACE THE ENTIRE SHEET.

6. WHERE LARGE ROCK IS USED, OR MACHINE PLACEMENT IS DIFFICULT, A MINIMUM 100mm LAYER OF FINE GRAVEL, AGGREGATE, OR SAND MAY BE NEEDED TO PROTECT THE FABRIC.

7. PLACEMENT OF ROCK SHOULD FOLLOW IMMEDIATELY AFTER PLACEMENT OF THE FILTER FABRIC. PLACE ROCK SO THAT IT FORMS A DENSE, WELL-GRADED MASS OF ROCK WITH A MINIMUM OF VOIDS. THE DESIRED DISTRIBUTION OF ROCK THROUGHOUT THE MASS MAY BE OBTAINED BY SELECTIVE LOADING AT THE QUARRY AND CONTROLLED DUMPING DURING FINAL PLACEMENT.

8. THE FINISHED SLOPE SHOULD BE FREE OF POCKETS OF SMALL ROCK OR CLUSTERS OF LARGE ROCKS. HAND PLACING MAY BE NECESSARY TO ACHIEVE THE PROPER DISTRIBUTION OF ROCK SIZES TO PRODUCE A RELATIVELY SMOOTH, UNIFORM SURFACE. THE FINISHED GRADE OF THE ROCK SHOULD BLEND WITH THE SURROUNDING AREA. NO OVERFALL OR PROTRUSION OF ROCK SHOULD BE APPARENT.

9. ENSURE THAT THE FINAL ARRANGEMENT OF THE SPILLWAY CREST WILL NOT PROMOTE EXCESSIVE FLOW THROUGH THE ROCK SUCH THAT THE WATER CAN BE RETAINED WITHIN THE SETTLING BASIN AN ELEVATION NO LESS THAN 50mm ABOVE OR BELOW THE NOMINATED SPILLWAY CREST ELEVATION.

MAINTENANCE

1. DURING THE CONSTRUCTION PERIOD, INSPECT THE SPILLWAY PRIOR TO FORECAST RAINFALL, DAILY DURING EXTENDED PERIODS OF RAINFALL, AFTER SIGNIFICANT RUNOFF PRODUCING STORM EVENTS, OR OTHERWISE ON A WEEKLY BASIS. MAKE REPAIRS AS NECESSARY.

2. CHECK FOR MOVEMENT OF, OR DAMAGE TO, THE SPILLWAY'S LINING, INCLUDING SURFACE CRACKING.

3. CHECK FOR SOIL SCOUR ADJACENT THE SPILLWAY. INVESTIGATE THE CAUSE OF ANY SCOUR, AND REPAIR AS NECESSARY.

4. WHEN MAKING REPAIRS, ALWAYS RESTORE THE SPILLWAY TO ITS ORIGINAL CONFIGURATION UNLESS AN AMENDED LAYOUT IS REQUIRED.

REMOVAL

1. TEMPORARY SPILLWAYS SHOULD BE REMOVED WHEN AN ALTERNATIVE, STABLE, DRAINAGE SYSTEM IS AVAILABLE.

2. REMOVE ALL MATERIALS AND DEPOSITED SEDIMENT, AND DISPOSE OF IN A SUITABLE MANNER THAT WILL NOT CAUSE AN EROSION OR POLLUTION HAZARD.

3. GRADE THE AREA IN PREPARATION FOR STABILISATION, THEN STABILISE THE AREA AS SPECIFIED IN THE APPROVED PLAN.

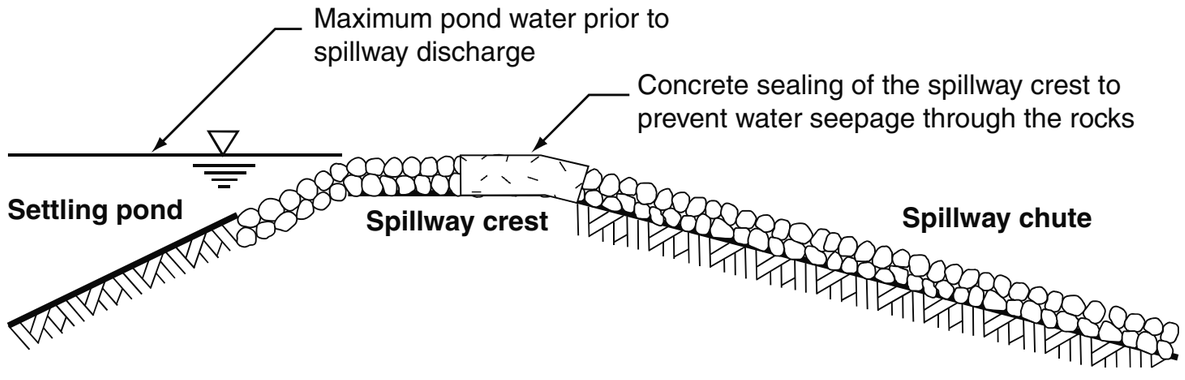


Figure 1 - Example of seepage control on the spillway crest

Drawn:	Date:		
GMW	Dec-09	Emergency Spillways	ES-1

INSTALLATION

1. REFER TO APPROVED PLANS FOR LOCATION, DIMENSIONS AND CONSTRUCTION DETAILS. IF THERE ARE QUESTIONS OR PROBLEMS WITH THE LOCATION, DIMENSIONS, OR METHOD OF INSTALLATION CONTACT THE ENGINEER OR RESPONSIBLE ON-SITE OFFICER FOR ASSISTANCE.

2. WHEREVER PRACTICAL, LOCATE THE LEVEL SPREADER ON UNDISTURBED, STABLE SOIL.

3. ENSURE FLOW DISCHARGING FROM THE LEVEL SPREADER WILL DISPERSE ACROSS A PROPERLY STABILISED SLOPE NOT EXCEEDING 10:1 (H:V) AND SUFFICIENTLY EVEN IN GRADE ACROSS THE SLOPE TO AVOID CONCENTRATING THE OUTFLOW.

4. THE OUTLET SILL OF THE SPREADER SHOULD BE PROTECTED WITH EROSION CONTROL MATTING TO PREVENT EROSION DURING THE ESTABLISHMENT OF VEGETATION. THE MATTING SHOULD BE A MINIMUM OF 1200mm WIDE EXTENDING AT LEAST 300mm UPSTREAM OF THE EDGE OF THE OUTLET CREST AND BURIED AT LEAST 150mm IN A VERTICAL TRENCH. THE DOWNSTREAM EDGE SHOULD BE SECURELY HELD IN PLACE WITH CLOSELY SPACED HEAVY-DUTY WIRE STAPLES AT LEAST 150mm LONG.

5. ENSURE THAT THE OUTLET SILL (CREST) IS LEVEL FOR THE SPECIFIED LENGTH.

6. IMMEDIATELY AFTER CONSTRUCTION, TURF, OR SEED AND MULCH WHERE APPROPRIATE, THE LEVEL SPREADER.

MAINTENANCE

1. INSPECT THE LEVEL SPREADER AFTER EVERY RAINFALL EVENT UNTIL VEGETATION IS ESTABLISHED.

2. AFTER ESTABLISHMENT OF VEGETATION OVER THE LEVEL SPREADER, INSPECTIONS SHOULD BE MADE ON A REGULAR BASIS AND AFTER RUNOFF-PRODUCING RAINFALL.

3. ENSURE THAT THERE IS NO SOIL EROSION AND THAT SEDIMENT DEPOSITION IS NOT CAUSING THE CONCENTRATION OF FLOW.

4. ENSURE THAT THERE IS NO SOIL EROSION OR CHANNEL DAMAGE UPSTREAM OF THE LEVEL SPREADER, OR SOIL EROSION OR VEGETATION DAMAGE DOWNSTREAM OF THE LEVEL SPREADER.

5. INVESTIGATE THE SOURCE OF ANY EXCESSIVE SEDIMENTATION.

6. MAINTAIN GRASS IN A HEALTH CONDITION WITH NO LESS THAN 90% COVER UNLESS CURRENT WEATHER CONDITIONS REQUIRE OTHERWISE.

7. GRASS HEIGHT SHOULD BE MAINTAINED AT A MINIMUM 50mm BLADE LENGTH WITHIN THE LEVEL SPREADER AND DOWNSTREAM DISCHARGE AREA, AND A MAXIMUM BLADE LENGTH NO GREATER THAN ADJACENT GRASSES.

REMOVAL

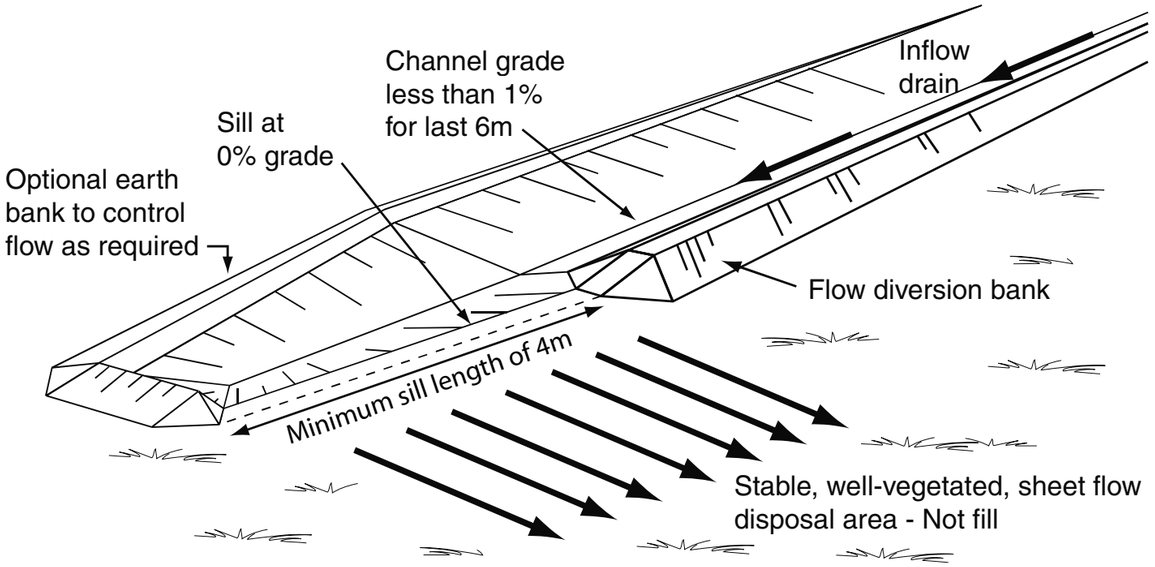
1. TEMPORARY LEVEL SPREADERS SHOULD BE DECOMMISSIONED ONLY AFTER AN ALTERNATIVE STABLE OUTLET IS OPERATIONAL, OR WHEN THE INFLOW CHANNEL IS DECOMMISSIONED.

2. REMOVE COLLECTED SEDIMENT AND DISPOSE OF IN A SUITABLE MANNER THAT WILL NOT CAUSE AN EROSION OR POLLUTION HAZARD.

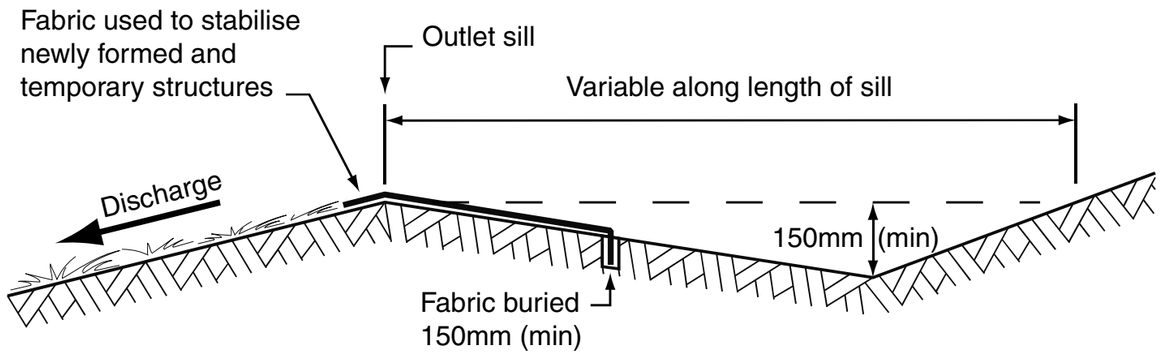
3. REMOVE AND APPROPRIATELY DISPOSE OF ANY EXPOSED GEOTEXTILE.

4. GRADE THE AREA AND SMOOTH IT OUT IN PREPARATION FOR STABILISATION.

5. STABILISE THE AREA AS SPECIFIED ON THE APPROVED PLAN.

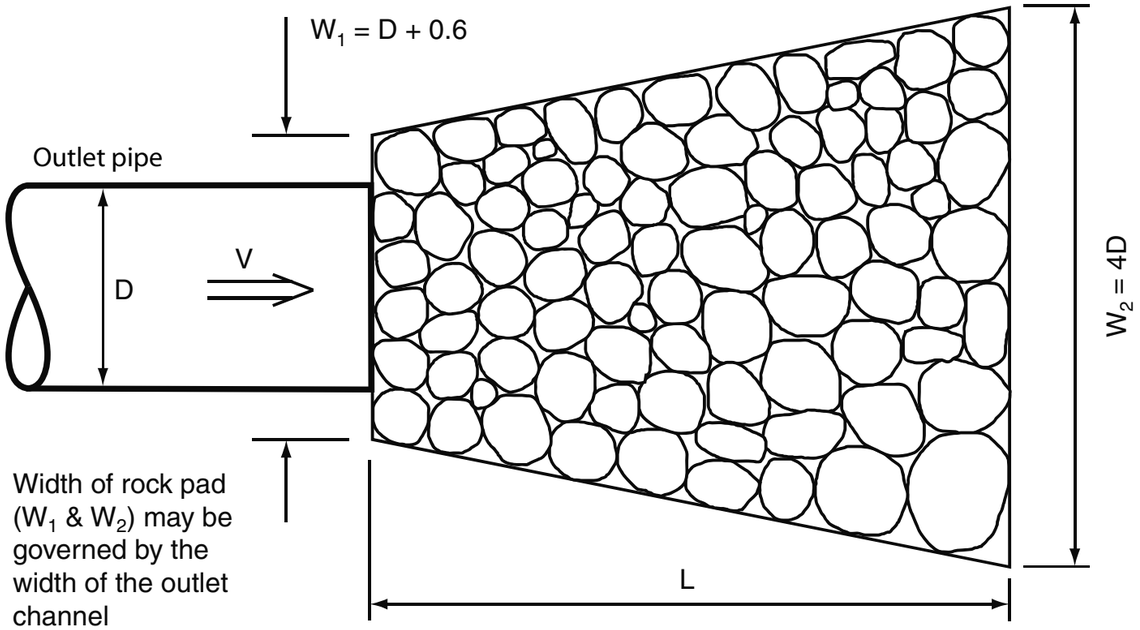


(a) Typical layout of level spreader

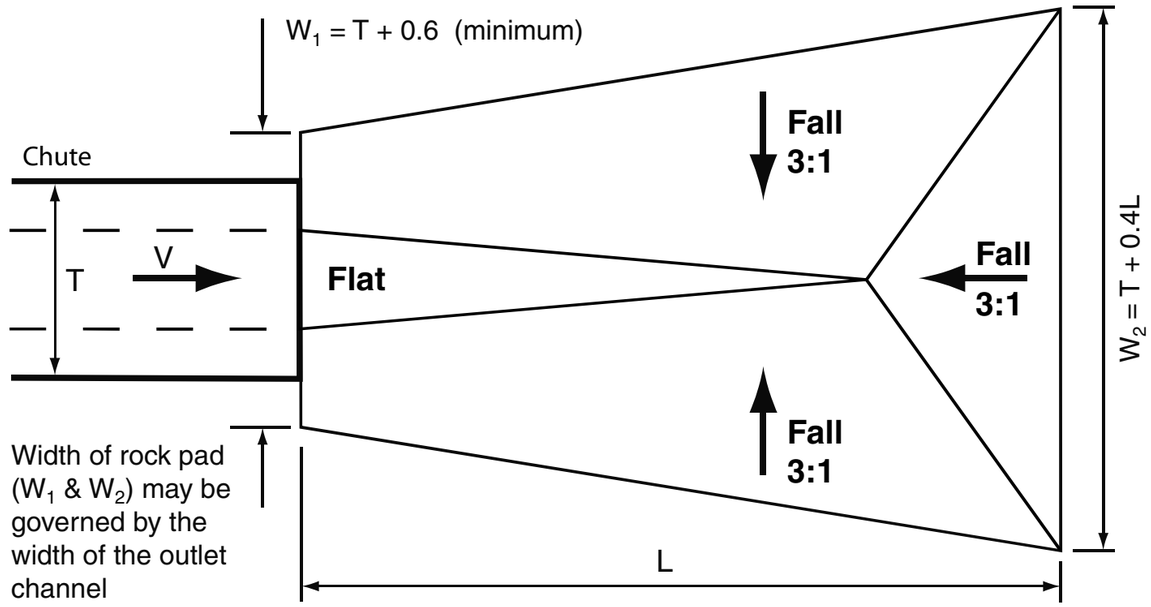


(b) Typical profile of the the outlet weir

Drawn:	Date:		
GMW	Dec-09	Level Spreaders	LS-01

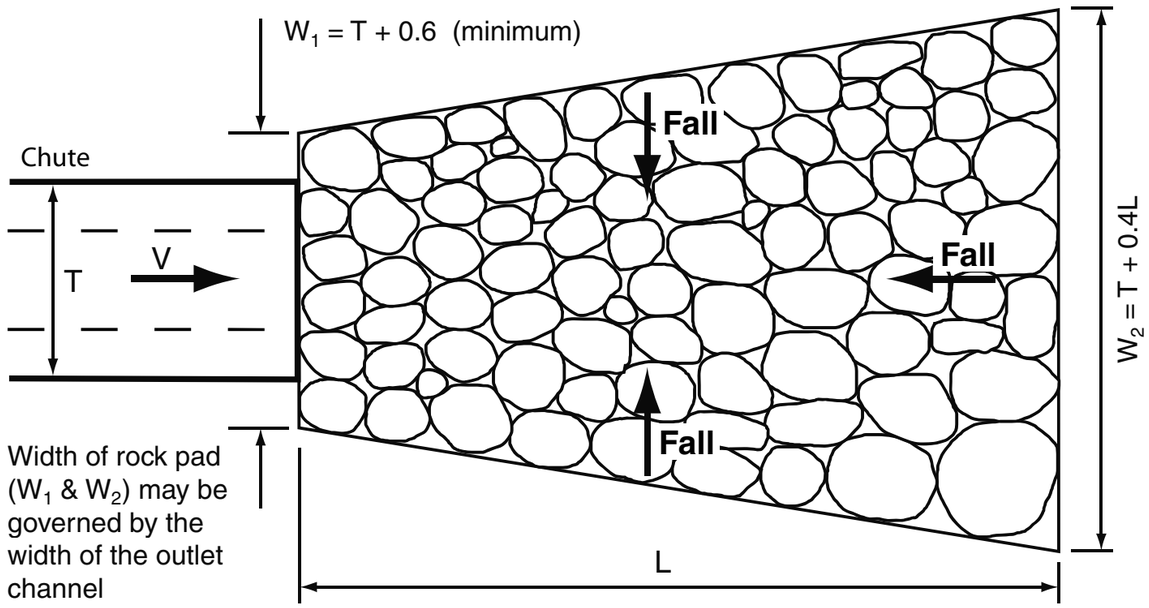


(a) Typical layout of a rock pad outlet structure for a pipe outlet

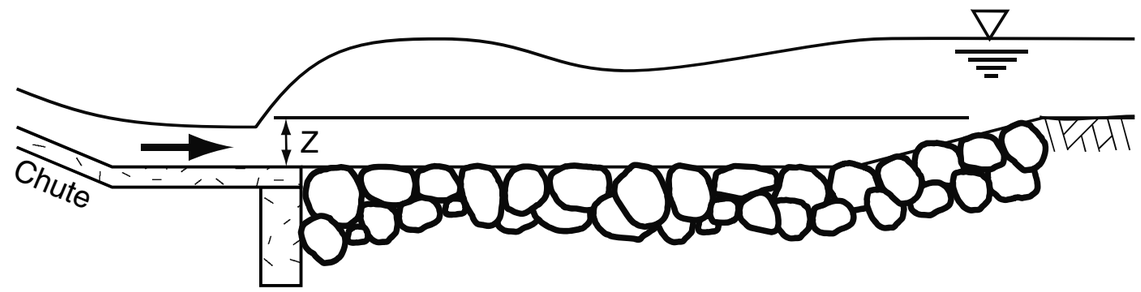


T = Maximum top width of flow at base of chute

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



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



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

Notes:

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

Drawn:	Date:		
GMW	Dec-09	Outlet Structures	OS-01

MATERIALS (ROCK PADS)

ROCK: HARD, ANGULAR, DURABLE, WEATHER RESISTANT AND EVENLY GRADED WITH 50% BY WEIGHT LARGER THAN THE SPECIFIED NOMINAL ROCK SIZE AND SUFFICIENT SMALL ROCK TO FILL THE VOIDS BETWEEN THE LARGER ROCK. THE DIAMETER OF THE LARGEST ROCK SIZE SHOULD BE NO LARGER THAN 1.5 TIMES THE NOMINAL ROCK SIZE. SPECIFIC GRAVITY TO BE AT LEAST 2.5.

GEOTEXTILE FABRIC: HEAVY-DUTY, NEEDLE-PUNCHED, NON-WOVEN FILTER CLOTH, MINIMUM BIDIM A24 OR EQUIVALENT.

INSTALLATION (ROCK PADS)

1. REFER TO APPROVED PLANS FOR LOCATION AND CONSTRUCTION DETAILS. IF THERE ARE QUESTIONS OR PROBLEMS WITH THE LOCATION, DIMENSIONS OR METHOD OF INSTALLATION CONTACT THE ENGINEER OR RESPONSIBLE ON-SITE OFFICER FOR ASSISTANCE.

2. THE DIMENSIONS OF THE OUTLET STRUCTURE MUST ALIGN WITH THE DOMINANT FLOW DIRECTION.

3. EXCAVATE THE OUTLET PAD FOOTPRINT TO THE SPECIFIED DIMENSION SUCH THE WHEN THE ROCK IS PLACED IN THE EXCAVATED PIT THE TOP OF THE ROCKS WILL BE LEVEL WITH THE SURROUNDING GROUND, UNLESS OTHERWISE DIRECTED.

4. IF THE EXCAVATED SOILS ARE DISPERSIVE, OVER-EXCAVATED THE ROCK PAD BY AT LEAST 300mm AND BACKFILL WITH STABLE, NON-DISPERSIVE MATERIAL.

5. LINE THE EXCAVATED PIT WITH GEOTEXTILE FILTER CLOTH, PREFERABLY USING A SINGLE SHEET. IF JOINTS ARE REQUIRED, OVERLAP THE FABRIC AT LEAST 300mm.

6. ENSURE THE FILTER CLOTH IS PROTECTED FROM PUNCHING OR TEARING DURING INSTALLATION OF THE FABRIC AND THE ROCK. REPAIR ANY DAMAGE BY REMOVING THE ROCK AND PLACING WITH ANOTHER PIECE OF FILTER CLOTH OVER THE DAMAGED AREA OVERLAPPING THE EXISTING FABRIC A MINIMUM OF 300mm.

7. ENSURE THERE ARE AT LEAST TWO LAYERS OF ROCKS. WHERE NECESSARY, REPOSITION THE LARGER ROCKS TO ENSURE TWO LAYERS OF ROCKS ARE ACHIEVED WITHOUT ELEVATING THE UPPER SURFACE ABOVE THE PIPE INVERT.

8. ENSURE THE ROCK IS PLACED IN A MANNER THAT WILL ALLOW WATER TO DISCHARGE FREELY FROM THE PIPE.

9. ENSURE THE UPPER SURFACE OF THE ROCK PAD DOES NOT CAUSE WATER TO BE DEFLECTED AROUND THE EDGE OF THE ROCK PAD.

10. IMMEDIATELY AFTER CONSTRUCTION, APPROPRIATELY STABILISE ALL DISTURBED AREAS.

MAINTENANCE

1. WHILE CONSTRUCTION WORKS CONTINUE ON THE SITE, INSPECT THE OUTLET STRUCTURE PRIOR TO FORECAST RAINFALL, DAILY DURING EXTENDED PERIODS OF RAINFALL, AFTER SIGNIFICANT RUNOFF PRODUCING RAINFALL, AND ON AT LEAST A WEEKLY BASIS.

2. REPLACE ANY DISPLACED ROCK WITH ROCK OF A SIGNIFICANTLY (MINIMUM 110%) LARGER SIZE THAN THE DISPLACED ROCK.

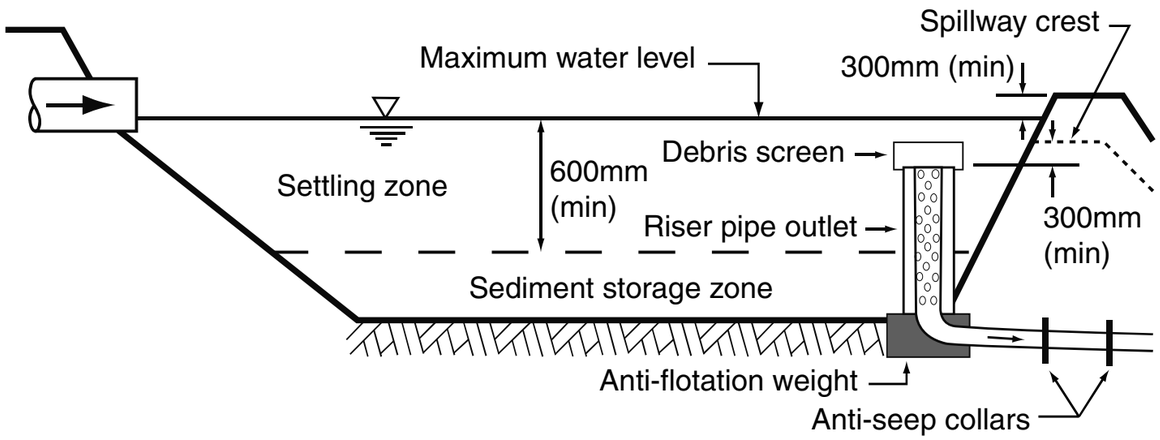
REMOVAL

1. TEMPORARY OUTLET STRUCTURES SHOULD BE COMPLETELY REMOVED, OR WHERE APPROPRIATE, REHABILITATED SO AS NOT TO CAUSE ONGOING ENVIRONMENTAL NUISANCE OR HARM.

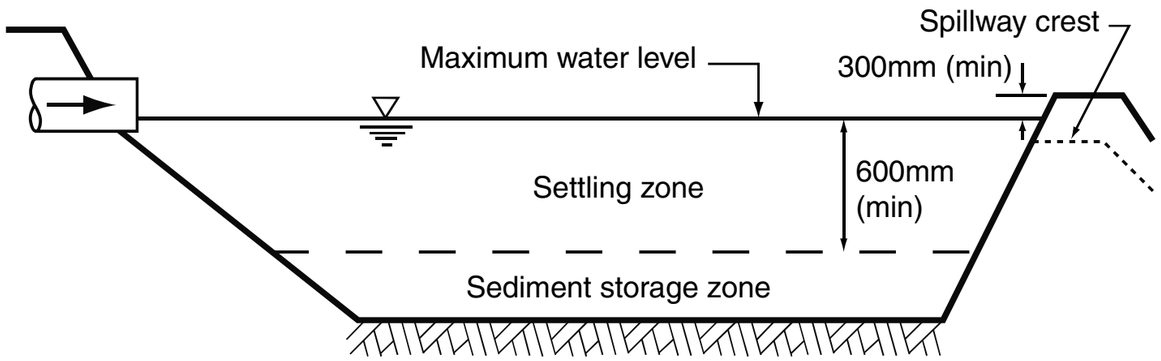
2. FOLLOWING REMOVAL OF THE DEVICE, THE DISTURBED AREA MUST BE APPROPRIATELY REHABILITATED SO AS NOT TO CAUSE ONGOING ENVIRONMENTAL NUISANCE OR HARM.

3. REMOVE MATERIALS AND COLLECTED SEDIMENT AND DISPOSE OF IN A SUITABLE MANNER THAT WILL NOT CAUSE AN EROSION OR POLLUTION HAZARD.

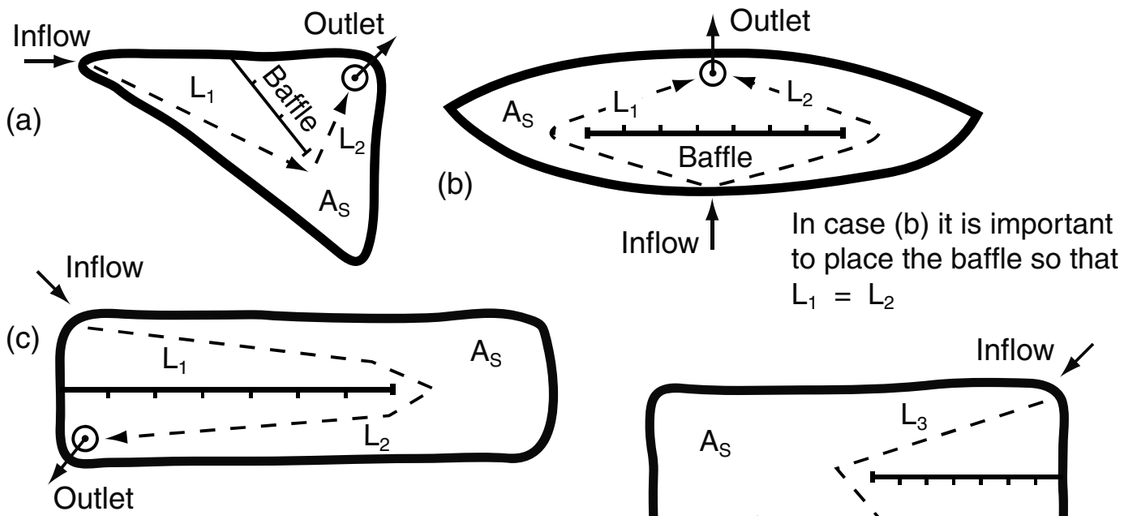
Drawn:	Date:		
GMW	Dec-09	Outlet Structure - Rock Pad	OS-02



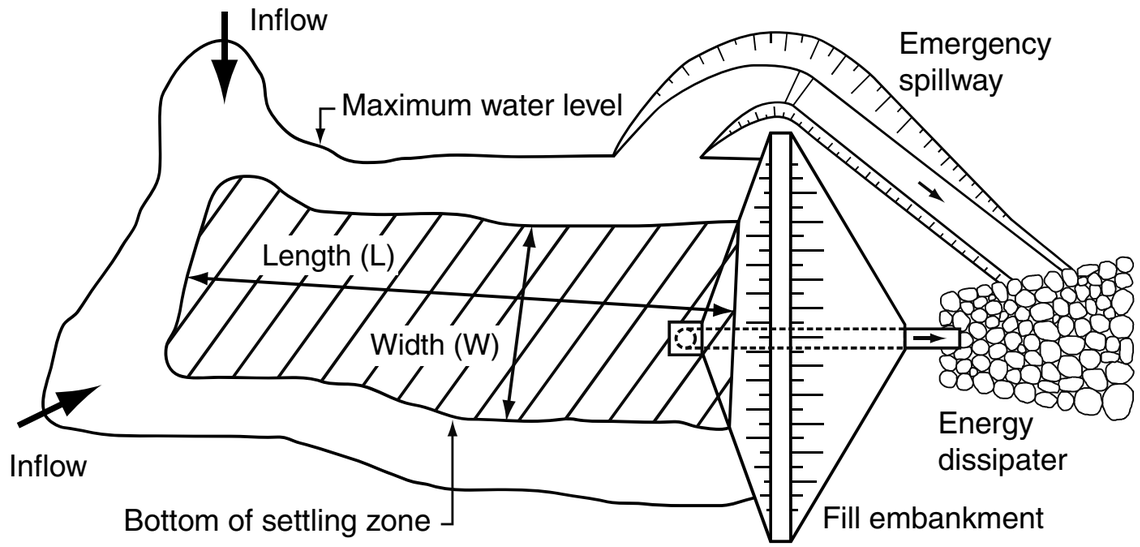
(a) Type C (dry) basin with riser pipe outlet system



(b) Typical profile of Type F/D (wet) basin

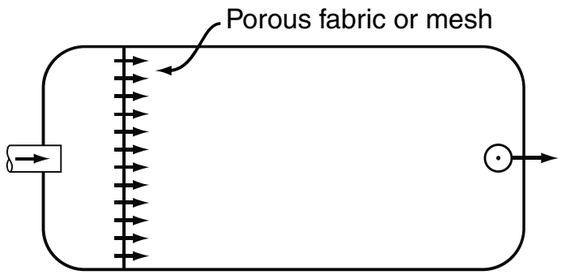


(c) Typical arrangement of internal flow control baffles

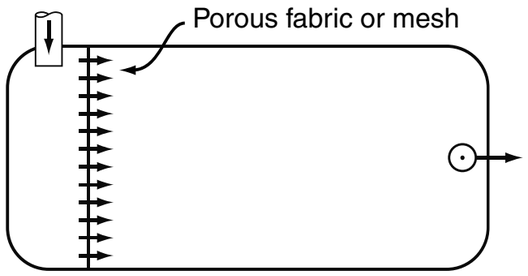


(d) Type C (dry) basin with riser pipe outlet system (plan view)

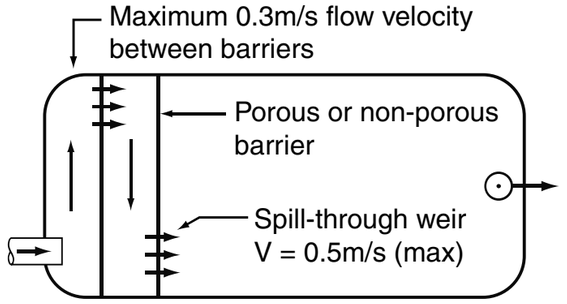
Drawn:	Date:		
GMW	Feb-10	Sediment Basins	SB-01



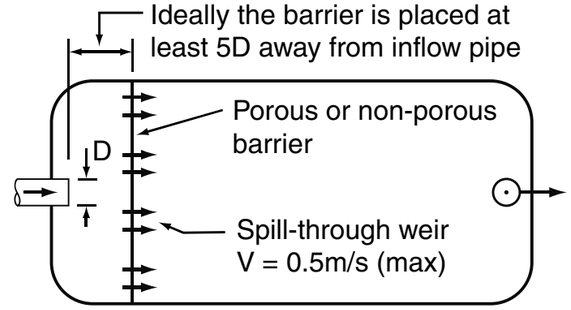
(a1) Porous barrier inlet chamber (plan view)



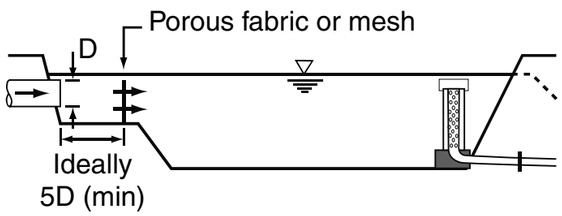
(b1) Porous barrier inlet chamber (plan view)



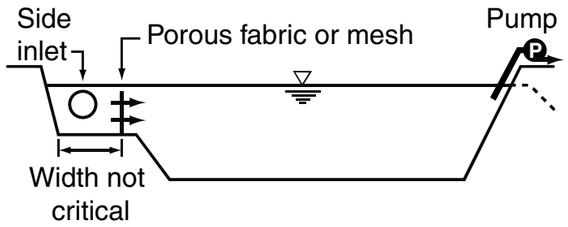
(c1) Alternative inlet chamber (plan view)



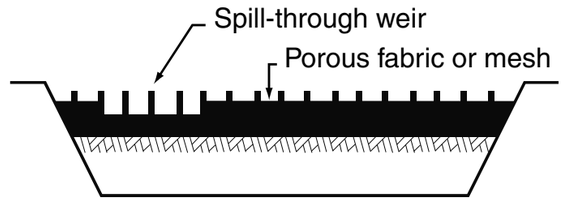
(d1) Alternative inlet chamber (plan view)



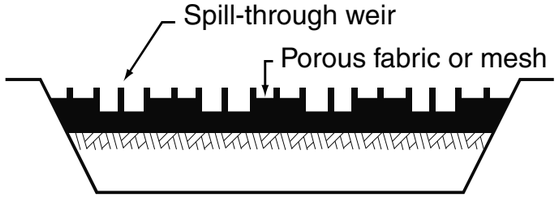
(a2) Typical layout of inlet chamber (long-section)



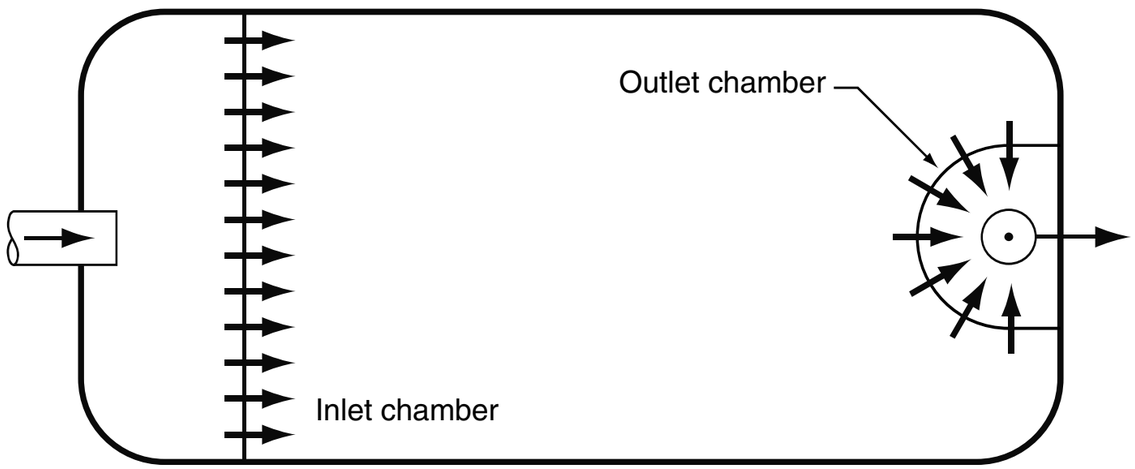
(b2) Typical layout of inlet chamber (long-section)



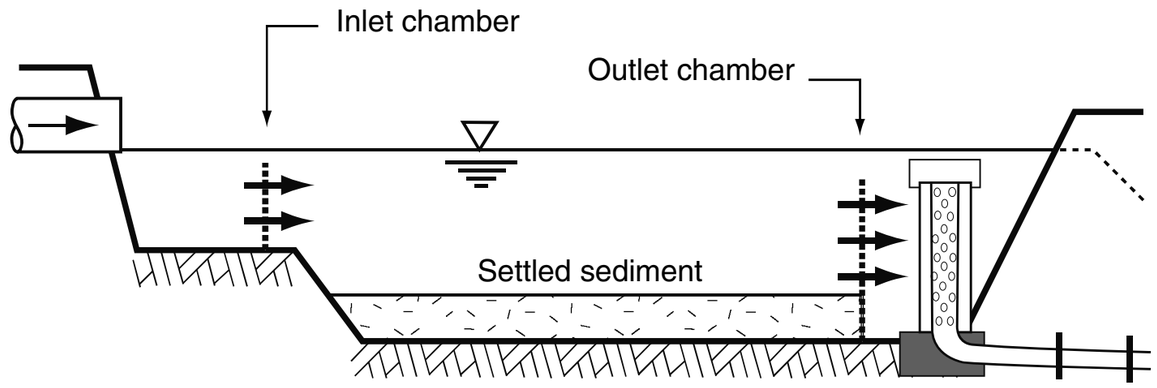
(c2) Single spill-through weir per barrier



(d2) Multiple spill-through weirs per barrier

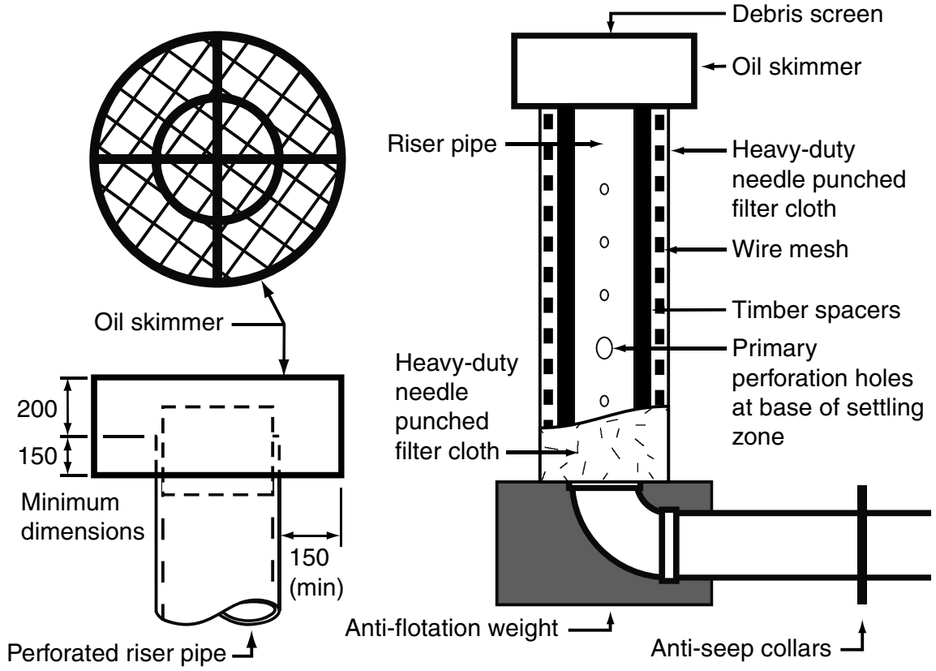


(e) Typical arrangement of inlet and outlet chambers (plan view)

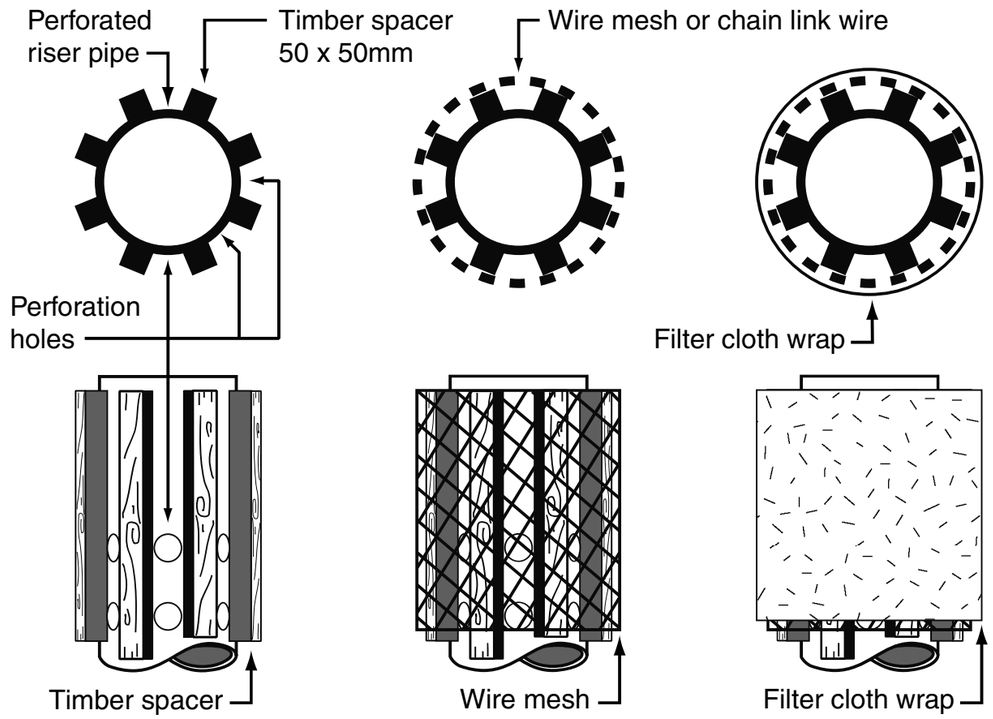


(f) Typical arrangement of inlet and outlet chambers (long-section)

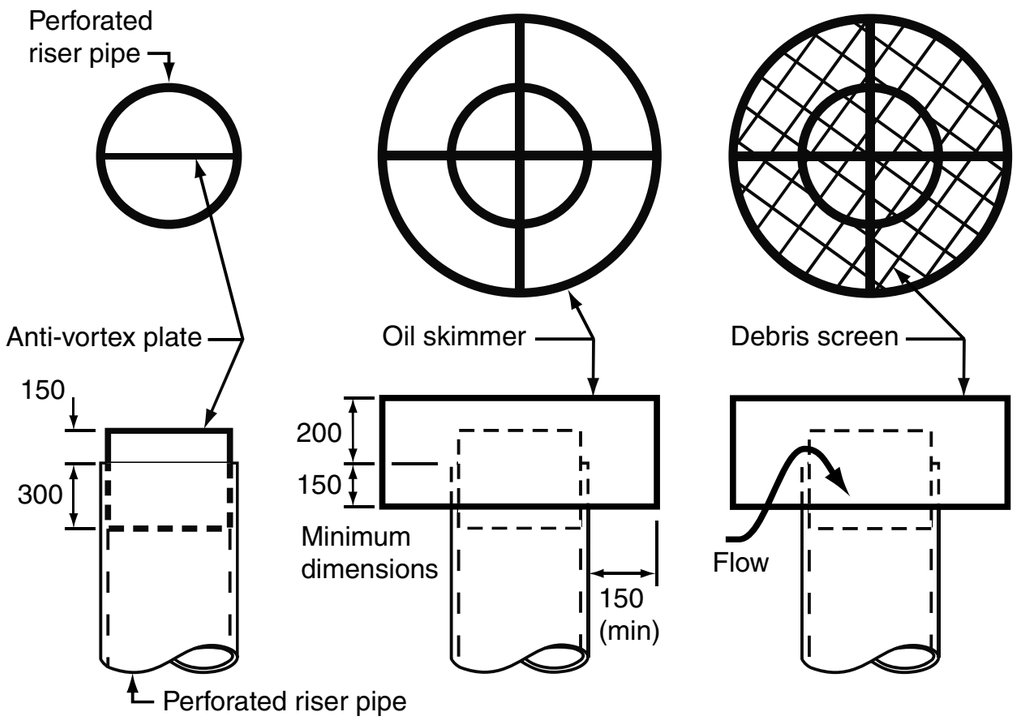
Drawn:	Date:		
GMW	Feb-10	Sediment Basins - Inlet Chambers and Outlet Chambers	SB-02



(a) Riser pipe outlet with geofabric filtration system



(b) Typical assembly of riser pipe with geotextile filter



(c) Anti-vortex plate, oil skimmer and debris screen

Drawn:	Date:		
GMW	Feb-10	Sediment Basins - Riser Pipe Primary Outlet System	SB-03

INSTALLATION OF RISER PIPE

1. DRILL DE-WATERING HOLES IN THE RISER AS SPECIFIED ON THE PLAN.

2. EXCAVATE ANTI-FLOTATION PIT.

3. SECURELY ATTACH THE RISER TO THE CONDUIT OR CONDUIT STUB TO MAKE A WATERTIGHT STRUCTURAL CONNECTION. SECURE ALL CONNECTIONS BETWEEN CONDUIT SECTIONS BY APPROVED WATERTIGHT ASSEMBLIES.

4. ATTACH THE ANTI-SEEP COLLARS TO THE CONDUIT AS SHOWN ON THE APPROVED PLAN, OR OTHERWISE AS SPECIFIED.

5. PLACE THE CONDUIT AND RISER ON A FIRM, SMOOTH FOUNDATION OF IMPERVIOUS SOIL. DO NOT USE PERVIOUS MATERIAL SUCH AS SAND, GRAVEL, OR CRUSHED ROCK AS BACKFILL AROUND THE CONDUIT OR ANTI-SEEP COLLARS.

6. PLACE FILL MATERIAL AROUND THE CONDUIT IN 100mm LAYERS AND COMPACT AROUND THE PIPE TO AT LEAST THE SAME DENSITY AS THE ADJACENT EMBANKMENT. ENSURE APPROPRIATE CARE IS TAKEN NOT TO RAISE THE PIPE FROM FIRM CONTACT WITH ITS FOUNDATION WHEN COMPACTING UNDER THE PIPE HAUNCHES.

7. PLACE A MINIMUM DEPTH OF 600mm OF LIGHTLY COMPACTED BACKFILL OVER THE CONDUIT BEFORE CROSSING IT WITH CONSTRUCTION EQUIPMENT.

8. ANCHOR THE RISER IN PLACE BY CONCRETE OR OTHER SATISFACTORY MEANS TO PREVENT FLOTATION. ENSURE THE ANTI-FLOTATION MASS IS AT LEAST 110% OF WATER MASS DISPLACED BY THE RISER PIPE OUTLET SYSTEM, INCLUDING THE VOLUME DISPLACED BY THE ANTI-FLOTATION WEIGHT.

9. IN NO CASE SHOULD THE CONDUIT BE INSTALLED BY CUTTING A TRENCH THROUGH THE DAM AFTER THE EMBANKMENT IS COMPLETED.

10. ATTACH ANTI-VORTEX DEVICE AND TRASH GUARD TO RISER AND AS REQUIRED (REFER TO SPECIFICATIONS SHOWN ON THE APPROVED PLANS).

MAINTENANCE

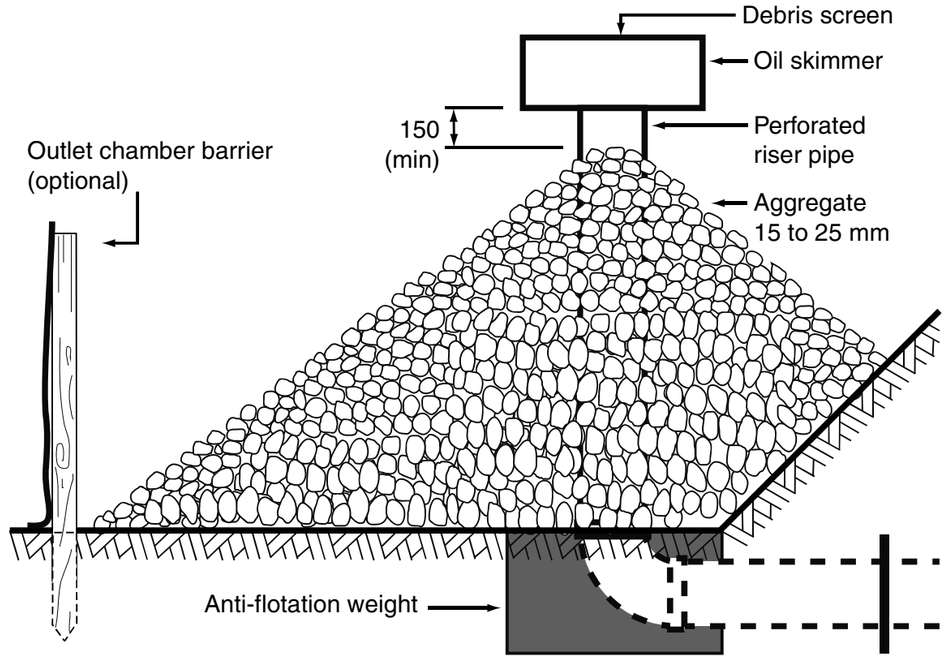
1. CHECK ALL VISIBLE PIPE CONNECTIONS FOR LEAKS, AND REPAIR AS NECESSARY.

2. REMOVE ALL TRASH AND OTHER DEBRIS FROM THE BASIN AND RISER.

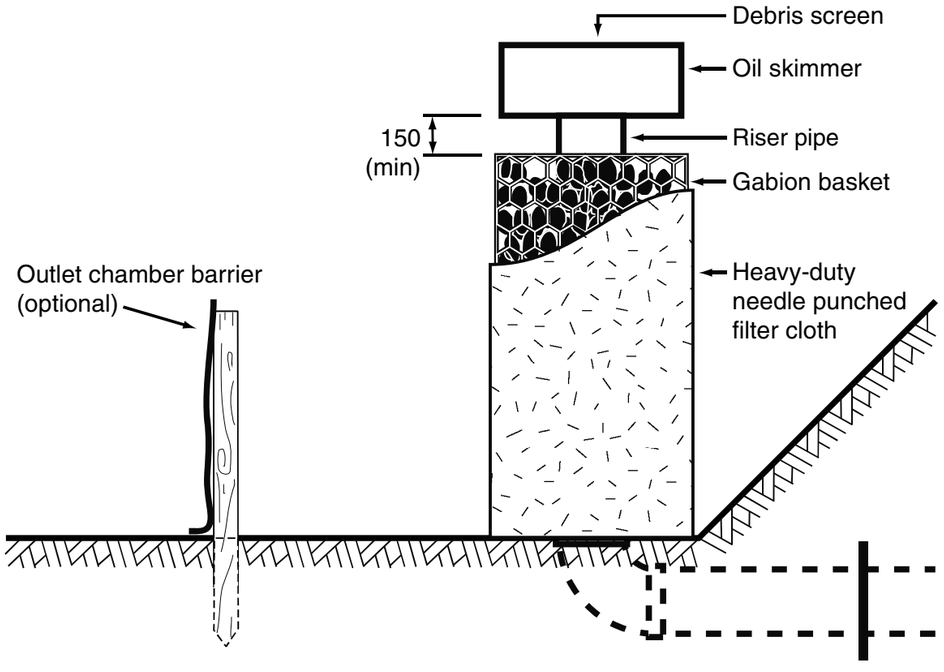
3. SUBMERGED INFLOW PIPES MUST BE INSPECTED AND DE-SILTED (AS REQUIRED) AFTER EACH INFLOW EVENT.

REMOVAL

1. DISPOSE OF ALL MATERIALS IN A MANNER THAT WILL NOT CREATE AN EROSION OR POLLUTION HAZARD.



(a) Riser pipe outlet with aggregate filtration system



(b) Riser pipe outlet with rock-filled gabion basket filter system

Drawn:	Date:		
GMW	Feb-10	Sediment Basins - Riser Pipe Primary Outlet System	SB-04

MATERIALS

EARTH FILL: CLEAN SOIL WITH EMERSON CLASS 2(1), 3, 4, OR 5, AND FREE OF ROOTS, WOODY VEGETATION, ROCKS AND OTHER UNSUITABLE MATERIAL. SOIL WITH EMERSON CLASS 4 AND 5 MAY NOT BE SUITABLE DEPENDING ON PARTICLE SIZE DISTRIBUTION AND DEGREE OF DISPERSION. CLASS 2(1) SHOULD ONLY BE USED UPON RECOMMENDATION FROM GEOTECHNICAL SPECIALIST. THIS SPECIFICATION MAYBE REPLACED BY AN EQUIVALENT STANDARD BASED ON THE EXCHANGEABLE SODIUM PERCENTAGE.

RISER PIPE: MINIMUM 250mm DIAMETER.

SPILLWAY ROCK: HARD, ANGULAR, DURABLE, WEATHER RESISTANT AND EVENLY GRADED ROCK WITH 50% BY WEIGHT LARGER THAN THE SPECIFIED NOMINAL (d50) ROCK SIZE. LARGE ROCK SHOULD DOMINATE, WITH SUFFICIENT SMALL ROCK TO FILL THE VOIDS BETWEEN THE LARGER ROCK. THE DIAMETER OF THE LARGEST ROCK SIZE SHOULD BE NO LARGER THAN 1.5 TIMES THE NOMINAL ROCK SIZE. THE SPECIFIC GRAVITY SHOULD BE AT LEAST 2.5.

GEOTEXTILE FABRIC: HEAVY-DUTY, NEEDLE-PUNCHED, NON-WOVEN FILTER CLOTH, MINIMUM 'BIDIM' A24 OR EQUIVALENT.

CONSTRUCTION

1. NOTWITHSTANDING ANY DESCRIPTION CONTAINED WITHIN THE APPROVED PLANS OR SPECIFICATIONS, THE CONTRACTOR SHALL BE RESPONSIBLE FOR SATISFYING THEMSELVES AS TO THE NATURE AND EXTENT OF THE SPECIFIED WORKS AND THE PHYSICAL AND LEGAL CONDITIONS UNDER WHICH THE WORKS WILL BE CARRIED OUT. THIS SHALL INCLUDE MEANS OF ACCESS, EXTENT OF CLEARING, NATURE OF MATERIAL TO BE EXCAVATED, TYPE AND SIZE OF MECHANICAL PLANT REQUIRED, LOCATION AND SUITABILITY OF WATER SUPPLY FOR CONSTRUCTION AND TESTING PURPOSES, AND ANY OTHER LIKE MATTERS AFFECTING THE CONSTRUCTION OF THE WORKS.

2. REFER TO APPROVED PLANS FOR LOCATION, DIMENSIONS, AND CONSTRUCTION DETAILS. IF THERE ARE QUESTIONS OR PROBLEMS WITH THE LOCATION, DIMENSIONS, OR METHOD OF INSTALLATION, CONTACT THE ENGINEER OR RESPONSIBLE ON-SITE OFFICER FOR ASSISTANCE.

3. BEFORE STARTING ANY CLEARING OR CONSTRUCTION, ENSURE ALL THE NECESSARY MATERIALS AND COMPONENTS ARE ON THE SITE TO AVOID DELAYS IN COMPLETING THE POND ONCE WORKS BEGIN.

4. INSTALL REQUIRED SHORT-TERM SEDIMENT CONTROL MEASURES DOWNSTREAM OF THE PROPOSED EARTHWORKS TO CONTROL SEDIMENT RUNOFF DURING CONSTRUCTION OF THE BASIN.

5. THE AREA TO BE COVERED BY THE EMBANKMENT, BORROW PITS AND INCIDENTAL WORKS, TOGETHER WITH AN AREA EXTENDING BEYOND THE LIMITS OF EACH FOR A DISTANCE NOT EXCEEDING FIVE (5) METRES ALL AROUND MUST BE CLEARED OF ALL TREES, SCRUB, STUMPS, ROOTS, DEAD TIMBER AND RUBBISH AND DISPOSED OF IN A SUITABLE MANNER. DELAY CLEARING THE MAIN POND AREA UNTIL THE EMBANKMENT IS COMPLETE.

6. ENSURE ALL HOLES MADE BY GRUBBING WITHIN THE EMBANKMENT FOOTPRINT ARE FILLED WITH SOUND MATERIAL, ADEQUATELY COMPACTED, AND FINISHED FLUSH WITH THE NATURAL SURFACE.
CUT-OFF TRENCH:

7. BEFORE CONSTRUCTION OF THE CUT-OFF TRENCH OR ANY ANCILLARY WORKS WITHIN THE EMBANKMENT FOOTPRINT, ALL GRASS GROWTH AND TOPSOIL MUST BE REMOVED FROM THE AREA TO BE OCCUPIED BY THE EMBANKMENT AND MUST BE DEPOSITED CLEAR OF THIS AREA AND RESERVED FOR TOPDRESSING THE COMPLETING THE EMBANKMENT.

8. EXCAVATE A CUT-OFF TRENCH ALONG THE CENTRE LINE OF THE EARTH FILL EMBANKMENT. CUT THE TRENCH TO STABLE SOIL MATERIAL, BUT IN NO CASE MAKE IT LESS THAN 600mm DEEP. THE CUT-OFF TRENCH MUST EXTEND INTO BOTH ABUTMENTS TO AT LEAST THE ELEVATION OF THE RISER PIPE CREST. MAKE THE MINIMUM BOTTOM WIDTH WIDE ENOUGH TO PERMIT OPERATION OF EXCAVATION AND COMPACTION EQUIPMENT, BUT IN NO CASE LESS THAN 600mm. MAKE THE SIDE SLOPES OF THE TRENCH NO STEEPER THAN 1:1 (H:V).

9. ENSURE ALL WATER, LOOSE SOIL, AND ROCK ARE REMOVED FROM THE TRENCH BEFORE BACKFILLING COMMENCES. THE CUT-OFF TRENCH MUST BE BACKFILLED WITH SELECTED EARTH-FILL OF THE TYPE SPECIFIED FOR THE EMBANKMENT, AND THIS SOIL MUST HAVE A MOISTURE CONTENT AND DEGREE OF COMPACTION THE SAME AS THAT SPECIFIED FOR THE SELECTED CORE ZONE.

10. MATERIAL EXCAVATED FROM THE CUT-OFF TRENCH MAY BE USED IN CONSTRUCTION OF THE EMBANKMENT PROVIDED IT IS SUITABLE AND IT IS PLACED IN THE CORRECT ZONE ACCORDING TO ITS CLASSIFICATION.

EMBANKMENT:

11. SCARIFY AREAS ON WHICH FILL IS TO BE PLACED BEFORE PLACING THE FILL.

12. ENSURE ALL FILL MATERIAL USED TO FORM THE EMBANKMENT MEETS THE SPECIFICATIONS CERTIFIED BY A SOIL SCIENTIST OR GEOTECHNICAL SPECIALIST.

13. THE FILL MATERIAL MUST CONTAIN SUFFICIENT MOISTURE SO IT CAN BE FORMED BY HAND INTO A BALL WITHOUT CRUMBLING. IF WATER CAN BE SQUEEZED OUT OF THE BALL, IT IS TOO WET FOR PROPER COMPACTION. PLACE FILL MATERIAL IN 150 TO 250mm CONTINUOUS LAYERS OVER THE ENTIRE LENGTH OF THE FILL AREA AND THEN COMPACT BEFORE PLACEMENT OF FURTHER FILL.

14. PLACE RISER PIPE OUTLET SYSTEM, IF SPECIFIED, IN APPROPRIATE SEQUENCE WITH THE EMBANKMENT FILLING. REFER TO SEPARATE INSTALLATION SPECIFICATIONS.

15. UNLESS OTHERWISE SPECIFIED ON THE APPROVED PLANS, COMPACT THE SOIL AT ABOUT 1% TO 2% WET OF OPTIMUM AND TO 95% MODIFIED OR 100% STANDARD COMPACTION.

16. WHERE BOTH DISPERSIVE AND NON-DISPERSIVE CLASSIFIED EARTH-FILL MATERIALS ARE AVAILABLE, NON-DISPERSIVE EARTH-FILL MUST BE USED IN THE CORE ZONE. THE REMAINING CLASSIFIED EARTH-FILL MATERIALS MUST ONLY BE USED AS DIRECTED BY [INSERT TITLE].

17. WHERE SPECIFIED, CONSTRUCT THE EMBANKMENT TO AN ELEVATION 10% HIGHER THAN THE DESIGN HEIGHT TO ALLOW FOR SETTLING; OTHERWISE FINISHED DIMENSIONS OF THE EMBANKMENT AFTER SPREADING OF TOPSOIL MUST CONFORM TO THE DRAWING WITH A TOLERANCE OF 75mm FROM THE SPECIFIED DIMENSIONS.

18. ENSURE DEBRIS AND OTHER UNSUITABLE BUILDING WASTE IS NOT PLACED WITHIN THE EARTH EMBANKMENT.

19. AFTER COMPLETION OF THE EMBANKMENT ALL LOOSE UNCOMPACTED EARTH-FILL MATERIAL ON THE UPSTREAM AND DOWNSTREAM BATTER MUST BE REMOVED PRIOR TO SPREADING OF TOPSOIL.

20. TOPSOIL AND REVEGETATE/STABILISED ALL EXPOSED EARTH AS DIRECTED WITHIN THE APPROVED PLANS.

(continued on SB-06)

Drawn:	Date:		
GMW	Feb-10	Sediment Basins	SB-05

SPILLWAY CONSTRUCTION:

21. THE SPILLWAY MUST BE EXCAVATED AS SHOWN ON THE PLANS, AND THE EXCAVATED MATERIAL IF CLASSIFIED AS SUITABLE, MUST BE USED IN THE EMBANKMENT, AND IF NOT SUITABLE IT MUST BE DISPOSED OF INTO SPOIL HEAPS.

22. ENSURE EXCAVATED DIMENSIONS ALLOW ADEQUATE BOXING-OUT SUCH THAT THE SPECIFIED ELEVATIONS, GRADES, CHUTE WIDTH, AND ENTRANCE AND EXIT SLOPES FOR THE EMERGENCY SPILLWAY WILL BE ACHIEVED AFTER PLACEMENT OF THE ROCK OR OTHER SCOUR PROTECTION MEASURES AS SPECIFIED IN THE PLANS.

23. PLACE SPECIFIED SCOUR PROTECTION MEASURES ON THE EMERGENCY SPILLWAY. ENSURE THE FINISHED GRADE BLENDS WITH THE SURROUNDING AREA TO ALLOW A SMOOTH FLOW TRANSITION FROM SPILLWAY TO DOWNSTREAM CHANNEL.

24. IF A SYNTHETIC FILTER FABRIC UNDERLAY IS SPECIFIED, PLACE THE FILTER FABRIC DIRECTLY ON THE PREPARED FOUNDATION. IF MORE THAN ONE SHEET OF FILTER FABRIC IS REQUIRED, OVERLAP THE EDGES BY AT LEAST 300mm AND PLACE ANCHOR PINS AT MINIMUM 1m SPACING ALONG THE OVERLAP. BURY THE UPSTREAM END OF THE FABRIC A MINIMUM 300mm BELOW GROUND AND WHERE NECESSARY, BURY THE LOWER END OF THE FABRIC OR OVERLAP A MINIMUM 300mm OVER THE NEXT DOWNSTREAM SECTION AS REQUIRED. ENSURE THE FILTER FABRIC EXTENDS AT LEAST 1000mm UPSTREAM OF THE SPILLWAY CREST.

25. TAKE CARE NOT TO DAMAGE THE FABRIC DURING OR AFTER PLACEMENT. IF DAMAGE OCCURS, REMOVE THE ROCK AND REPAIR THE SHEET BY ADDING ANOTHER LAYER OF FABRIC WITH A MINIMUM OVERLAP OF 300mm AROUND THE DAMAGED AREA. IF EXTENSIVE DAMAGE IS SUSPECTED, REMOVE AND REPLACE THE ENTIRE SHEET.

26. WHERE LARGE ROCK IS USED, OR MACHINE PLACEMENT IS DIFFICULT, A MINIMUM 100mm LAYER OF FINE GRAVEL, AGGREGATE, OR SAND MAY BE NEEDED TO PROTECT THE FABRIC.

27. PLACEMENT OF ROCK SHOULD FOLLOW IMMEDIATELY AFTER PLACEMENT OF THE FILTER FABRIC. PLACE ROCK SO THAT IT FORMS A DENSE, WELL-GRADED MASS OF ROCK WITH A MINIMUM OF VOIDS. THE DESIRED DISTRIBUTION OF ROCK THROUGHOUT THE MASS MAY BE OBTAINED BY SELECTIVE LOADING AT THE QUARRY AND CONTROLLED DUMPING DURING FINAL PLACEMENT.

28. THE FINISHED SLOPE SHOULD BE FREE OF POCKETS OF SMALL ROCK OR CLUSTERS OF LARGE ROCKS. HAND PLACING MAY BE NECESSARY TO ACHIEVE THE PROPER DISTRIBUTION OF ROCK SIZES TO PRODUCE A RELATIVELY SMOOTH, UNIFORM SURFACE. THE FINISHED GRADE OF THE ROCK SHOULD BLEND WITH THE SURROUNDING AREA. NO OVERFALL OR PROTRUSION OF ROCK SHOULD BE APPARENT.

29. ENSURE THAT THE FINAL ARRANGEMENT OF THE SPILLWAY CREST WILL NOT PROMOTE EXCESSIVE FLOW THROUGH THE ROCK SUCH THAT THE WATER CAN BE RETAINED WITHIN THE SETTLING BASIN AN ELEVATION NO LESS THAN 50mm ABOVE OR BELOW THE NOMINATED SPILLWAY CREST ELEVATION. ESTABLISHMENT OF SETTLING POND:

30. THE AREA TO BE COVERED BY THE STORED WATER OUTSIDE THE LIMITS OF THE BORROW PITS MUST BE CLEARED OF ALL SCRUB AND RUBBISH. TREES MUST BE CUT DOWN STUMP HIGH AND REMOVED FROM THE IMMEDIATE VICINITY OF THE WORK.

31. ESTABLISH ALL REQUIRED INFLOW CHUTES AND INLET BAFFLES, IF SPECIFIED, TO ENABLE WATER TO DISCHARGE INTO THE BASIN IN A MANNER THAT WILL NOT CAUSE SOIL EROSION OR THE RE-SUSPENSION OF SETTLED SEDIMENT.

32. INSTALL A SEDIMENT STORAGE LEVEL MARKER POST WITH A CROSS MEMBER SET JUST BELOW THE TOP OF THE SEDIMENT STORAGE ZONE (AS SPECIFIED ON THE APPROVED PLANS). USE AT LEAST A 75mm WIDE POST FIRMLY SET INTO THE BASIN FLOOR.

33. IF SPECIFIED, INSTALL INTERNAL SETTLING POND BAFFLES. ENSURE THE CREST OF THESE BAFFLES IS SET LEVEL WITH, OR JUST BELOW, THE ELEVATION OF THE EMERGENCY SPILLWAY CREST.

34. INSTALL ALL APPROPRIATE MEASURES TO MINIMISE SAFETY RISK TO ON-SITE PERSONNEL AND THE PUBLIC CAUSED BY THE PRESENCE OF THE SETTLING POND. AVOID STEEP, SMOOTH INTERNAL SLOPES. APPROPRIATELY FENCE THE SETTLING POND AND POST WARNING SIGNS IF UNSUPERVISED PUBLIC ACCESS IS LIKELY OR THERE IS CONSIDERED TO BE AN UNACCEPTABLE RISK TO THE PUBLIC.

MAINTENANCE OF SEDIMENT BASIN

1. INSPECT THE SEDIMENT BASIN DURING THE FOLLOWING PERIODS:

(i) DURING CONSTRUCTION TO DETERMINE WHETHER MACHINERY, FALLING TREES, OR CONSTRUCTION ACTIVITY HAS DAMAGED ANY COMPONENTS OF THE SEDIMENT BASIN. IF DAMAGE HAS OCCURRED, REPAIR IT.

(ii) AFTER EACH RUNOFF EVENT. INSPECT THE EROSION DAMAGE AT FLOW ENTRY AND EXIT POINTS. IF DAMAGE HAS OCCURRED, MAKE THE NECESSARY REPAIRS.

(iii) AT LEAST WEEKLY DURING THE NOMINATED WET SEASON (IF ANY) OTHERWISE AT LEAST FORTNIGHTLY.

(iv) PRIOR TO, AND IMMEDIATELY AFTER, PERIODS OF 'STOP WORK' OR SITE SHUTDOWN.

2. CLEAN OUT ACCUMULATED SEDIMENT WHEN IT REACHES THE MARKER BOARD/POST, AND RESTORE THE ORIGINAL STORAGE VOLUME. PLACE SEDIMENT IN A DISPOSAL AREA OR, IF APPROPRIATE, MIX WITH DRY SOIL ON THE SITE.

3. DO NOT DISPOSE OF SEDIMENT IN A MANNER THAT WILL CREATE AN EROSION OR POLLUTION HAZARD.

4. CHECK ALL VISIBLE PIPE CONNECTIONS FOR LEAKS, AND REPAIR AS NECESSARY.

5. CHECK ALL EMBANKMENTS FOR EXCESSIVE SETTLEMENT, SLUMPING OF THE SLOPES OR PIPING BETWEEN THE CONDUIT AND THE EMBANKMENT; MAKE ALL NECESSARY REPAIRS.

6. REMOVE ALL TRASH AND OTHER DEBRIS FROM THE BASIN AND RISER.

7. SUBMERGED INFLOW PIPES MUST BE INSPECTED AND DE-SILTED (AS REQUIRED) AFTER EACH INFLOW EVENT.

REMOVAL OF SEDIMENT BASIN

1. WHEN GRADING AND CONSTRUCTION IN THE DRAINAGE AREA ABOVE A TEMPORARY SEDIMENT BASIN IS COMPLETED AND THE DISTURBED AREAS ARE ADEQUATELY STABILISED, THE BASIN MUST BE REMOVED OR OTHERWISE INCORPORATED INTO THE PERMANENT STORMWATER DRAINAGE SYSTEM. IN EITHER CASE, SEDIMENT SHOULD BE CLEARED AND PROPERLY DISPOSED OF AND THE BASIN AREA STABILISED.

2. BEFORE STARTING ANY MAINTENANCE WORK ON THE BASIN OR SPILLWAY, INSTALL ALL NECESSARY SHORT-TERM SEDIMENT CONTROL MEASURES DOWNSTREAM OF THE SEDIMENT BASIN.

3. ALL WATER AND SEDIMENT MUST BE REMOVED FROM THE BASIN PRIOR TO THE DAM'S REMOVAL. DISPOSE OF SEDIMENT AND WATER IN A MANNER THAT WILL NOT CREATE AN EROSION OR POLLUTION HAZARD.

4. BRING THE DISTURBED AREA TO A PROPER GRADE, THEN SMOOTH, COMPACT, AND STABILISE AND/OR REVEGETATE AS REQUIRED TO ESTABLISH A STABLE LAND SURFACE.

Drawn:	Date:		
GMW	Feb-10	Sediment Basins	SB-06

1. Erosion Hazard and Sediment Basins

Site Name: Running Stream

Site Location:

Precinct/Stage:

Other Details:

Site area	Sub-catchment or Name of Structure						Notes
	Dam	CWD	Pit S1	Pit S2	Pit S3		
Total catchment area (ha)	1	33.5	1.7	7.57	18.8		
Disturbed catchment area (ha)	1		1.7	7.57	18.8		

Soil analysis (enter sediment type if known, or laboratory particle size data)

Sediment Type (C, F or D) if known:	D	D	D	D	D		From Appendix C (if known)
% sand (fraction 0.02 to 2.00 mm)							Enter the percentage of each soil fraction. E.g. enter 10 for 10%
% silt (fraction 0.002 to 0.02 mm)							
% clay (fraction finer than 0.002 mm)							
Dispersion percentage							E.g. enter 10 for dispersion of 10%
% of whole soil dispersible							See Section 6.3.3(e). Auto-calculated
Soil Texture Group	D	D	D	D	D		Automatic calculation from above

Rainfall data

Design rainfall depth (no of days)	5	5	5	5	5		See Section 6.3.4 and, particularly, Table 6.3 on pages 6-24 and 6-25.
Design rainfall depth (percentile)	90	90	90	90	90		
x-day, y-percentile rainfall event (mm)	31.4	31.4	31.4	31.4	31.4		
Rainfall R-factor (if known)							Only need to enter one or the other here
IFD: 2-year, 6-hour storm (if known)	5.91	5.91	5.91	5.91	5.91		

RUSLE Factors

Rainfall erosivity (*R* -factor)	1000	1000	1000	1000	1000		Auto-filled from above
Soil erodibility (*K* -factor)	0.05	0.05	0.05	0.05	0.05		RUSLE LS factor calculated for a high rill/interrill ratio.
Slope length (m)	50	300	300	300	300		
Slope gradient (%)	10	5	20	20	20		
Length/gradient (*LS* -factor)	2.04	2.53	20.02	20.02	20.02		
Erosion control practice (*P* -factor)	1.3	1.3	1.3	1.3	1.3	1.3	
Ground cover (*C* -factor)	1	1	1	1	1	1	

Sediment Basin Design Criteria (for Type D/F basins only. Leave blank for Type C basins)

Storage (soil) zone design (no of months)	2	2	2	2	2	2	Minimum is generally 2 months
Cv (Volumetric runoff coefficient)	0.64	0.64	0.64	0.64	0.64		See Table F2, page F-4 in Appendix F

Calculations and Type D/F Sediment Basin Volumes

Soil loss (t/ha/yr)	132	164	1301	1301	1301		
Soil Loss Class	1	2	6	6	6		See Table 4.2, page 4-13
Soil loss (m^3/ha/yr)	102	126	1001	1001	1001		Conversion to cubic metres
Sediment basin storage (soil) volume (m^3)	17		284	1263	3136		See Sections 6.3.4(i) for calculations
Sediment basin settling (water) volume (m^3)	201	6732	342	1521	3778		See Sections 6.3.4(i) for calculations
Sediment basin total volume (m^3)	218		626	2784	6914		

NB for sizing of Type C (coarse) sediment basins, see Worksheet 3 (if required).

Appendix B: NSW Water Harvestable Rights Calculation

Maximum Harvestable Right Dam Capacity

Information you provided

1. The approximate mid-point location of the landholding is:

- Latitude: **-33.032044**
- Longitude: **149.862423**

2. Total landholding area is **330 Hectares**

Result

The combined maximum dam capacity of all harvestable right dams on your landholding is **26.4** ML (megalitres).

Date

12/10/2022

Important information

Location of dams

The maximum harvestable right capacity calculator does not verify that the location of the proposed dam is lawful. It is up to the landholder to ensure the proposed dam site complies with the location requirements set out in the harvestable rights order.

Information on determining stream order and where dams can be built can be found in the Harvestable rights dams - where can they be built? fact sheet and on the DPE website frequently asked questions.

Harvestable rights dams cannot be constructed on or within three kilometres of a Ramsar wetland site, listed at the time of construction or first use of the dam. There are currently 12 Ramsar wetlands in NSW.

Overall dam capacity on a landholding

The calculator determines the combined maximum dam capacity for all potential harvestable rights dams on a landholding.

The calculator does not take into account the capacity of existing dams on your landholding. If you have existing harvestable rights dams on your landholding, you must take the capacity of

these dams into account when constructing new dams or enlarging existing dams, up to the calculated maximum dam capacity for your landholding. See the department's frequently asked questions for further information.

Maximum dam capacity in the coastal-draining catchments

For landholdings in the coastal-draining catchments harvestable rights area, the calculator will provide two dam capacity values, referencing 10% **and** 30% of rainfall runoff.

The **maximum dam capacity for the landholding is the volume with reference to 30% of the rainfall runoff** only and **is not** the combined total of the 10% and 30% of rainfall runoff values.

Further assessment in the coastal-draining catchment areas

The department will commence more detailed assessments in each catchment in 2022 to determine the appropriateness of the coastal harvestable right limit increase from 10% to 30% of rainfall runoff. Adjustments could be made to harvestable rights limits in certain coastal-draining catchments following the assessments.

Landholders who choose to construct a new dam or enlarge an existing dam to access the additional harvestable right greater than 10% from 13 May 2022, but before the catchment assessments have been completed, do so at their own risk. Any dams built or enlarged within this timeframe will need to be resized at a later date if the harvestable rights limit is reduced and a lower limit is determined in the catchment.

Dams on landholdings that straddle the central inland-draining and coastal-draining catchments harvestable rights areas

Each of the harvestable rights areas have different maximum dam capacity limits. Harvestable rights dams may only be constructed up to the maximum dam capacity in the relevant harvestable rights area on the landholding.

For example, the calculator may estimate that the maximum dam capacity of all harvestable right dams within the central inland-draining catchments harvestable rights area of a landholding is 10 ML, while the maximum dam capacity (with reference to 30% of rainfall runoff) of all harvestable right dams within the coastal-draining catchment of the same landholding is 30 ML. In this example, any harvestable rights dam(s) constructed within the inland-draining catchment area of this landholding can have a combined capacity no greater than 10 ML. Harvestable rights dam(s) constructed within the coastal-draining catchment area of this landholding can have a combined capacity no greater than 30 ML.

Default one megalitre dams on small landholdings

If a landholding resulted from a subdivision approved by a relevant planning authority (for example, local councils) before 1 January 1999 and the maximum dam capacity for the landholding is less than 1 megalitre, the maximum dam capacity for that landholding is taken to be 1 megalitre.

No further harvestable right dams may be constructed on the landholding and any new dams above one megalitre must be licensed.

Appendix C: Drill Hole BH7 Log

Name of Hole: BH7

Project Number: 7876

Project: Running Stream Borehole Review
Location: Running Stream
Logged by: G.Thomson

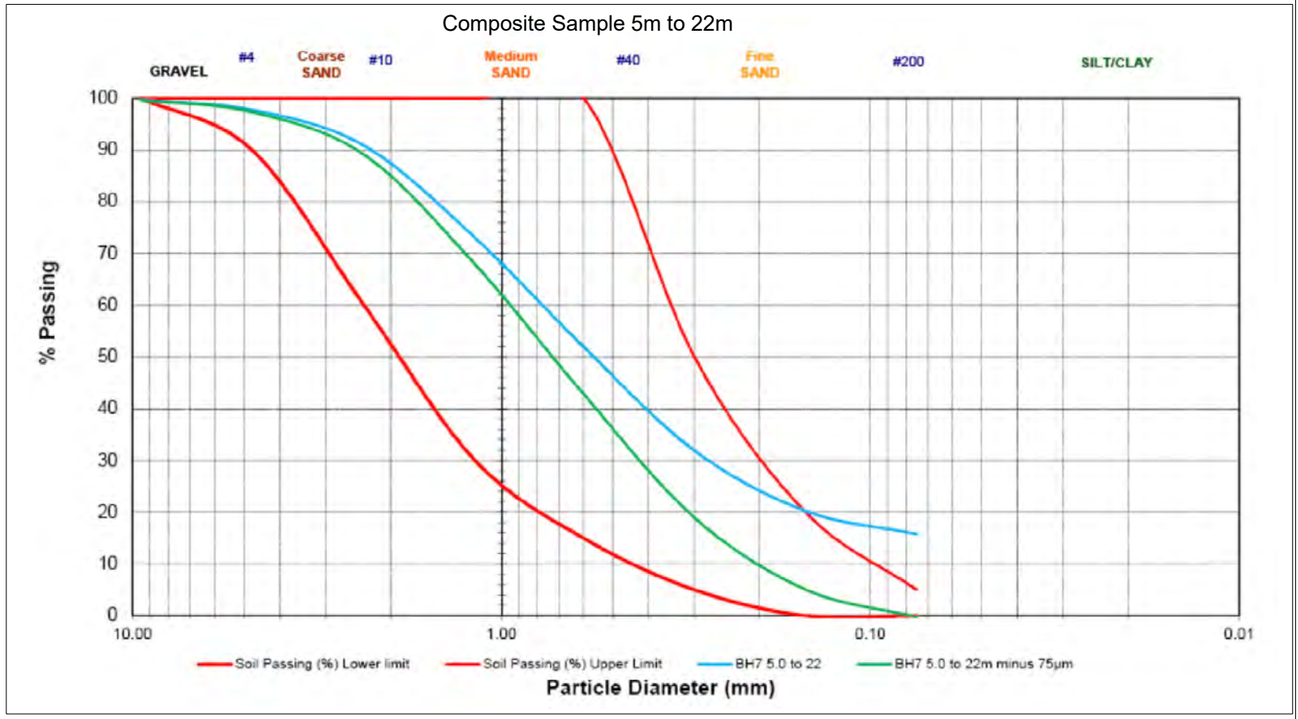
PLANTATION PINE PRODUCTS AUSTRALIA PTY LTD

Date Commenced: 20/01/2020
Date Completed: 20/01/2020
Approximate Surface RL: 1074
Approximate Coordinates:766866E 6341482N
Drilling Contractor: Total Drilling

vgt Environmental Compliance Solutions

Elevation (mAHD)	Depth (m)	Peizo	Photo	Graphic Log	Stratum Thickness (m)	Pebble Size (mm)	Description	Sizing Results
1074	0				1		SOIL sand and gravel	
1072	2				3	2-25mm	WEATHERED CONGLOMERATE sandstone and clay matrix, pebbles	
1070	4				5	up to 20mm	WEATHERED SANDSTONE pebbled, coarse to very coarse grained, clay matrix, occasional pebbles	
1068	6							
1066	8							
1064	10							
1062	12				13	2-10mm	WEATHERED SANDSTONE pebbles, coarse to very coarse grained	
1060	14							
1058	16							
1056	18							
1054	20							
1052	22				1		WEATHERED SANDSTONE with claystone	
					1		WEATHERED SANDSTONE, coarse to very coarse grained	
1050	24				1		WEATHERED SANDSTONE with claystone	
1048	26				2		WEATHERED SANDSTONE coarse to very coarse grained	
1046	28				2		WEATHERED SANDSTONE very coarse grained, wet	
1044	30				1		WEATHERED SANDSTONE very coarse	

Composite Sample 5m to 22m



Other Information:

Log Created By: TO 10/02/2020

Checked By:

Version: V0 10/02/2020

Name of Hole: BH7

Project Number: 7876

Project: Running Stream Borehole Review
Location: Running Stream
Logged by: G.Thomson

PLANTATION PINE PRODUCTS AUSTRALIA PTY LTD

Date Commenced: 20/01/2020
Date Completed: 20/01/2020
Approximate Surface RL: 1074
Approximate Coordinates:766866E 6341482N
Drilling Contractor: Total Drilling

Elevation (mAHD)	Depth (m)	Peizo	Photo	Graphic Log	Stratum Thickness (m)	Pebble Size (mm)	Description	Sizing Results
1044	30						grained, wet	

Other Information:

Log Created By: TO 10/02/2020	**Checked By:**	**Version:** V0 10/02/2020

vgt environmental compliance solutions and laboratories

Beyond Compliance

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