TITLE: SOIL AND WATER MANAGEMENT PLAN

Badgerys Creek Brick Manufacture and Quarry Operations
235 Martin Road, Badgerys Creek, NSW, 2171

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Badgerys Creek Clay Mine Surface Water Management Plan	
Name of Mine	Badgerys Creek Clay Mine
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Signature of Approved Suitably Qualified Person	
Date	

Revision Table

Date	Version	Author	Reviewed	Approved
21/7/2019	BRK-BAD-3.10.7-P07_VGT10	TO	RM	RM
30/8/2019	BRK-BAD-3.10.7-P09_V1	TO	LGT	JB
22/9/2020	BRK-BAD-3.10.7-P09_V2	TO	LGT	JB
25/11/2020	BRK-BAD-3.10.7-P09_V3	TO	JB/DPIE	JB
28/01/2021	BRK-BAD-3.10.7-P09_V4	TO	JB	JB

1.0 Introduction

1.1. Purpose

In accordance with the Schedule 3 Condition 23 of the Project Approval, CSR Building Products Ltd (CSR)are required to develop and implement an onsite Soil and Water Management Plan which includes a Site Water Balance, and a Surface Water Management Plan. The Dewatering Management Plan (Condition 23B) and the Dewatering Infrastructure Plan (Condition 23A) will be addressed in a separate document. The aim of this Soil and Water Management Plan (SWMP) is to be a dynamic document which will be updated over the life of quarry operations until 27th September 2031.

The SWMP accounts for changes to site drainage over the life of the project that have been broadly addressed, within general measures, to be implemented onsite throughout the course of the quarry operations. Further erosion and sediment control measures will be specifically developed on an ongoing basis as extraction progresses and the need arises.

Table 1 summarises the Water Management conditions of approval, presented under Condition 23 Schedule 3 of the Project Approval (DPIE, 2020).

Table 1. ***Summary of Project Approval Conditions***

Schedule and Clause	Condition of Project Approval	Location of where addressed in document
3 (23)	The Proponent must prepare a Soil and Water Management Plan for the project to the satisfaction of the Secretary. This plan must:	
3 (23)a	be prepared by a suitably qualified and experienced person/s approved by the Secretary;	Appendix C
3 (23)b	be prepared in consultation with the Council and DPIE Water;	Annexure to this report- Water Management Consultation and Correspondence
3 (23)c	be submitted to the Secretary for approval prior to commencing Phase 1, unless otherwise agreed by the Secretary; and	Approval for this plan will be obtained prior to commencing Phase 1

Schedule and Clause	Condition of Project Approval	Location of where addressed in document
3 (23)d (i)	include a: (i) Site Water Balance that includes details of: • sources and security of water supply; • water use and management on site; • adequacy of water storage facilities to contain all surface water runoff; • all existing Water Access Licences and potential Water Access Licences, including information on the relevant Water Sharing Plan and Water Sources; • any off-site water transfers; including those described in Condition 23A of this Schedule; • reporting procedures; and • measures to be implemented to minimise clean water use on site;	Section 0, Section 5.0, Section 4.2, Section 5.5 & Section 10.0,
3(23)d (ii)	Surface Water Management Plan, that includes: • a program for obtaining detailed baseline data on surface water flows and quality in water bodies that could potentially be affected by the project;	Section 4.2.4 and Section 4.5
	a detailed description of the surface water management system on site including the: • clean water diversion system; • erosion and sediment controls; • dirty water management system; and • water storages, including the area, depth and capacity of any in-pit sumps;	Section 4.0
	detailed plans, including design objectives and performance criteria, for: • reinstatement of drainage lines on the rehabilitated areas of the site; and • control of any potential water pollution from rehabilitated areas of the site;	Section 4.3, Figure 4

Schedule and Clause	Condition of Project Approval	Location of where addressed in document
	performance criteria for the following, including trigger levels for investigating any potentially adverse impacts on: • the water management system; • surface water quality in creeks and other water bodies that could potentially affected by the project (including Badgerys Creek and Badgerys Creek tributary); and • the stream health, vegetation health and channel stability of water bodies that could potentially affected by the project;	Section 4.4
	program to monitor and report on: • any surface water discharges; • the effectiveness of the water management system; • the quality of water discharged from the site to the environment; • surface water flows and quality in local watercourses; and • the stream health, riparian vegetation health and channel stability of creeks and other water bodies that could potentially be affected by the project;	Section 4.0 and Section 4.5
	A plan to respond to any exceedances of the performance criteria, and mitigate and/or offset any adverse surface water impacts of the project;	Section 6.0
3(23)d (iii)	Groundwater Management Plan that includes: • measures to ensure that the maximum extraction depth is not exceeded (see condition 23 of Schedule 3);	Section 6.0, Section 7.0, and Section 8.0
	• Measures to ensure that the maximum extraction depth is not exceeded (see condition 23 of Schedule 3);	Section 6.2
	• A protocol to obtain appropriate water licence(s) to cover the volume of any unforeseen groundwater inflows into the quarry from the quarry face or floor;	WAL 24346 obtained, Section 2.2
	• Groundwater assessment criteria, including trigger levels for investigating any potentially adverse groundwater impacts; and	Section 8.0
	• A monitoring program to manage potential impacts, if any, on any alluvium and associated surface water near the proposed extraction area that includes:	Section 7.0
	○ Monitoring of boreholes within the alluvial sediments adjacent to Badgerys and South Creeks and their tributaries, and in the Bringelly Shale bedrock aquifer;	Section 7.1

Schedule and Clause	Condition of Project Approval	Location of where addressed in document
	○ Monitoring of groundwater inflows into the quarry from the quarry face or floor, or into any pit sumps;	Section 7.2
	○ Monitoring the impacts of the project on baseflows to Badgerys and South Creeks and their tributaries;	Section 7.5
	○ Identification of a methodology for determining exceedances of the assessment criteria;	Section 8.0
	○ A plan to respond to any exceedances of the performance criteria and	Section 8.0
	○ A program to regularly report on monitoring.	Section 10.0
Management Plan Requirements		
5 (3)	The Proponent must ensure that the management plans required under this approval are prepared in accordance with any relevant guidelines, and include:	
5 (3) a	a summary of relevant background or baseline data;	Section 4.2.4, Section 7.4
5 (3) b	a description of: • the relevant statutory requirements (including any relevant approval, licence or lease conditions); • any relevant limits or performance measures/criteria; and • the specific performance indicators that are proposed to be used to judge the performance of, or guide the implementation of, the project or any management measures;	Section 2.0, Section 4.4, Section 8.0 Section 4.4, Section 8.0
5 (3) c	a description of the measures to be implemented to comply with the relevant statutory requirements, limits, or performance measures/criteria;	Section 4.0, Section 9.0, Section 6.0, Section 7.0, Section 8.0, Section 10.0
5 (3) d	a program to monitor and report on the: • impacts and environmental performance of the project; and • effectiveness of any management measures (see (c) above);	Section 4.0, Section 9.0, Section 6.0, Section 7.0, Section 8.0, Section 10.0
5 (3) e	a contingency plan to manage any unpredicted impacts and their consequences and to ensure that ongoing impacts reduce to levels below relevant impact assessment criteria as quickly as possible;	Section 10.0
5 (3) f	a program to investigate and implement ways to improve the environmental performance of the project over time;	Section 11.0

Schedule and Clause	Condition of Project Approval	Location of where addressed in document
5 (3) g	a protocol for managing and reporting any: • incidents; • complaints; and • non-compliances with statutory requirements;	Section 10.0
5 (3) h	a protocol for periodic review of the plan; and	Section 11.0
5 (3) i	a document control table that includes version numbers, dates when the management plan was prepared and reviewed, names and positions of the person/s who prepared and reviewed the management plan, a description of any revisions made and the date of the Secretary's approval.	Included in Header

Table 2. *Statement of Commitments (Appendix 6 of Conditions of Consent)*

Schedule and Clause	Commitment	Location of where addressed in document
General		
1)	The Proponent will implement all practicable measures to prevent or minimise harm to the environment that may result from the construction, operation or rehabilitation of the Project.	This report and its implementation.
2)	CSR will apply to amend EPL 684 to reflect the project.	Section 0
3)	The environmental management strategy and sub plans will be amended to reflect the project.	This Report
Surface Water		
25)	**Stormwater Management** The Proponent shall manage surface water on the Project Site in accordance with the WMP prepared for the Project Site and revised for the project, including surface water management measures include in the Modification 3 and 4 EA and the RTS.	This Report
26)	If during the operational phase of the quarry or on completion of the quarry operations, the proponent wishes to make use of the water from the pits/dams in the brick making process or for reuse at other premises offsite etc, a licence will be obtained from DPIE.	Section 0
27)	Sediment basins 4, 5 and 6 and the new basins at the raw material stockpile area and Pit 3 will be sized and operated in accordance with Landcom's (2004) Managing Urban Stormwater: Soils & Construction. If any of these basins are to be modified to perform additional stormwater treatment functions in future (other than sediment capture), then appropriate modelling and design of the basins will be required at that time. In this case monitoring of discharges from the basin at Pit 3 to South Creek will be required.	Section 4.2.3
28)	The site WMP will be revised prior to commencement of the modification to include the revised surface water management approach, and monitoring of any water discharged from the site.	This Report Section 11.1
29)	**Monitoring** Electrical conductivity, pH, total nitrogen, total suspended solids, turbidity, total alkalinity, arsenic and copper will be monitored at the discharge points to Badgerys Creek and South Creek. Discharges will be monitored daily during the first month of continuous discharge, then weekly if the first month of data does not exceed concentration limits. Monitoring will revert to daily if any limits are exceeded and/or concentrations are reduced below limits.	Not Applicable Addressed in the Dewatering Management Plan

Schedule and Clause	Commitment	Location of where addressed in document
30)	Total dissolved solids, total phosphorus, arsenic, cadmium, chromium, lead, nickel, zinc and mercury will be sampled weekly during the first two months, which will reduce to monthly if there are no exceedances	Not Applicable Addressed in the Dewatering Management Plan
31)	The analytes previously sampled in Pit 1 will be monitored at three depth levels from the surface to 6 m at two locations near the discharge point to Badgerys Creek. Water will be monitored weekly for three weeks prior to discharge, then monthly. This monitoring will continue for the life of the project, and in the perched treatment basin described above.	Not Applicable Addressed in the Dewatering Management Plan
32)	Similar sampling is also required for the new basin at Pit 3 if the basin is being used to treat Pit 3 water (other than sediment capture). The list of analytes may be able to be reduced according to the future quality of stormwater collected in Pit 3.	Not Applicable The new basin at Pit 3 will not be required. See Section 4.2.3 for details of new dams to be constructed.
33)	**Licensing and approvals** 33.CSR will apply to the EPA to amend the EPL to incorporate the discharge rates and concentration limits for relevant physical and chemical stressors, and toxicants, at the discharge point to Badgerys Creek.	Section 0
34)	CSR will apply to the EPA to amend the EPL, if and when required, to incorporate appropriate discharge rates and concentration limits for discharges from the basin at Pit 3, for which time the basin provides additional water treatment other than sediment capture.	Not Applicable The new basin at Pit 3 will not be required. See Section 4.2.3 for details of new dams to be constructed.
35)	CSR will consult DPIE Water on the need for water licenses associated with the modification.	Section 0
36)	The EPA will be engaged, post approval, to determine whether the pit water must be classified in terms of the Protection of the Environment Operations Act 1997 (POEO Act) and to include the discharge point in the EPL.	Not Applicable Addressed in the Dewatering Management Plan
37)	**Erosion and Sediment Control** Erosion and sediment controls will be implemented at the pit areas once they are filled with VENM and rehabilitation has commenced. These measures will remain in place until surfaces are fully stabilised.	Table 12
38)	Erosion and sediment controls will be implemented along the unsealed VENM haul road, which will direct runoff to the pits or local sediment traps.	Table 12

Schedule and Clause	Commitment	Location of where addressed in document
Groundwater		
39)	The Proponent shall prepare and implement a Groundwater Monitoring Program for the Project Site generally in accordance with the methodology provided in Chapter 11 of the 2011 EA, subject to consultation with the DPIE (water, lands and primary industry) and the satisfaction of the Director-General of the DP&I.	Section 7.0
40)	The WMP will be updated to include the groundwater monitoring network and a TARP for exceedances of groundwater criteria, which will be developed based on the baseline groundwater data.	Figure Three Section 9.0
41)	The Proponent shall report the results of the Groundwater Monitoring Program to the Secretary of the DPIE on an annual basis.	Section 10.0
42)	The Proponent shall implement appropriate management measures in relation to groundwater as indicated by the Monitoring Program and agreed with the Secretary.	Section 7.0
43)	A licence to authorise any groundwater monitoring installation, required as part of this project, shall be obtained from the DPIE Water prior to any drilling commencing.	Section 2.0
44)	The proponent shall implement an alluvial aquifer mapping and assessment program to inform: ▪ The definition of the boundaries of the alluvial system. ▪ Adjustment to the extent of proposed pits to avoid impacts to the alluvial aquifer. ▪ The establishment of further mitigation measures (if required) to minimise potential impacts upon the alluvial aquifer. ▪ This program will commence within 12 months of recommencing quarrying operations and the results will be reported to the Secretary of the DPIE.	Appendix I Section 7.5

1.2. Objectives

The following objectives are informed by the conditions of approval and have been used to guide the basis for site water management for this report:

- Maximise the amount of undisturbed areas onsite;
- Separate clean and dirty water onsite;
- Maximise opportunities for onsite water reuse;
- Mitigate potential impacts on the Badgerys Creek by implementing a 50-metre buffer zone;
- Monitor both the alluvial aquifer and the deeper shale aquifer; and
- Report findings to Water NSW/NRAR and DPIE annually.

1.3. Background

CSR is operating an existing quarry in Badgerys Creek, extracting clay resources and using these to manufacture bricks for the construction industry. These quarrying and brick making activities have been undertaken on the site for over 30 years. In May 2018, a modification (Mod 2) to the development approval was granted by the Minister for Planning to continue operations on the site, including extracting from existing and future new pits, exportation of raw materials and importation and storage of finished brick products.

A MOD 3 and MOD 4 Application was submitted to DPIE in 2019 and approved on 11th August 2020. In September 2019 a Response to Submissions (RTS) was lodged that made changes to the MOD 3 & 4 application to address feedback received and this became known as the Preferred Project. Under the Preferred Project the respective applications allow for:

MOD 3

- The development of an advanced manufacturing facility;
- Re-commence operations at the site as approved in the Project Approval, and expel the current mothballed status of the site;
- An increase in the importation of raw materials from off-site for use in both the brick making and roof products manufacturing facilities; and
- Modifications to the approved noise bunds.

MOD 4

- The dewatering of Pit 1;
- Continued extraction of clay material from Pit 3 to a depth of 35 m below natural ground level;
- The importation of Virgin Excavated Natural Material (VENM) to backfill Pit 1-3 and to rehabilitate the site to facilitate future development.

1.4. Site Overview

The Badgerys Creek Brickworks (Site) is located at 235 Martin Road, Badgerys Creek, 41 kilometres to the south west of Sydney, within the Liverpool City Council Local Government Area (LGA) (see *Figure One)*. Primary access to the site is provided through Martin Road at the north eastern corner of the site. Features of the existing site are shown on *Figure Two.*

Under the approved operations expansion, CSR plans to excavate Pit 3 as modified, and rehabilitate Pits 1 and 2 by dewatering and backfilling. Brick making will recommence and the manufacturing areas will be developed as per Mod 3 and 4 and the Preferred Project, detailed in the October 2019 Return to Submission Document to DP&E. An underground pipeline will be installed under Badgerys Creek to transfer water (up to 10ML per day) from Pit 1 to a water storage Basin on the Western Sydney Airport (WSA) site.

Under the development, no surface water will be permitted to be captured within Pit 1, 2 and 3, aside from incident rainfall on the surface of the dams. Dirty surface water from the stockpile areas, construction and rehabilitation areas will be collected within a series of sediment basins to be constructed. Provision will also be made to allow for the treatment and discharge of this water to Badgerys Creek via modification to an existing EPL.

1.5. Alignment to Other Management Plans

1.5.1. Surface Water Plans

This Plan builds upon existing water management plans prepared by ERM (2002) and AECOM (2010) for the Site. AECOM was engaged to assess the impact that the proposed quarry expansion would have on water management at the site, in particular the ability to contain site runoff. The report was informed by water balancing modelling for achieving no offsite discharge over a 10-year period following excavation of the last pit (Pit 5) under the proposed operational expansion works. The AECOM assessment built upon the previous Soil and Water Management Plan prepared for the Site by ERM in 2002.

The plan also references the Mod 3 Surface Water Assessment undertaken by Advisian Pty Ltd in February 2019 and the Mod 4 Surface Water Management and Dewatering Strategy undertaken by Advisian Pty Ltd.

Any rehabilitation programs, rehabilitation strategies, and Rehabilitation Management Plans developed, in accordance with Conditions of Approval, will inform the objectives of this plan and water management outcomes.

1.5.2. Groundwater Plans

The original Groundwater Management Plan was prepared by Hyder Consulting Pty Ltd (April 2013). This report builds upon that report and considers consultation undertaken with the then OEH (now EPA), NOW (now Water NSW/NRAR), and DPIE.

1.6. Surface Water Consultation

Condition 23.b), Schedule 3 of the Mod 3 & 4 (The Preferred) Project Approval requires that the Water Management Plan be prepared in consultation with the NSW Department of Planning, Industry and Environment- Water (DPIE Water) and Liverpool Council. A draft copy of this Plan will be provided to each of these agencies for comment prior to submission of a final draft to the Department of Planning for approval. Telephone and Email consultation has been undertaken with representatives from Council, EPA and DPIE Water to support the development of this Plan.

A previous draft plan for Mod 2 has been submitted the DPIE post approval and comments were provided (see Annexure to this report- Water Management Consultation and Correspondence). An amended draft plan was submitted in August 2019 and further comments were in turn received from DPIE. The table below summarises these comments relevant to water management of the Site that require actions and where addressed in this report.

Table 3. ***DPIE Mod 2 Post Approval Environmental Management Plan Comments***

Relevant Consent Condition	Comment (from Appendix A)	Where Addressed in this Report
a) Be prepared by a suitably qualified and experienced person/s approved by the Secretary;	Append evidence of approval	Appendix C
b) Be prepared in consultation with the EPA and DPIE Water	Further consultation required	Annexure to this report- Water Management Consultation and Correspondence
A Site Water Balance that: includes details of: • sources and security of water supply;	See Table 5 – Please include the volumes of inflows and out flows of each source presented per annum and the total balance of inflows and outflows per annum.	Section 5.1
• water use on site;	Satisfied- Section 3 and Section 4	
• adequacy of water storage facilities to contain all surface water runoff; and	See Section 3.2, Figure 3 and Section 5.2.3 – The Department notes the SWMP indicates there will be environmental discharges without an EPL which allows for this. The Department requests PGH consult with the EPA about this matter. Furthermore, surface water monitoring will be required at any locations where discharges are	Section 3.6, Section 4.2.3 Only clean water is permitted to flow from the site.

Relevant Consent Condition	Comment (from Appendix A)	Where Addressed in this Report
• any off-site water transfers;	proposed, therefore current surface water monitoring locations are inadequate. See above.	No EPL will be sought at this stage.
(ii) Surface Water Management Plan, that includes: • a program for obtaining detailed baseline data on surface water flows and quality in water bodies that could potentially be affected by the project;	See Figure 4 – It appears water will be discharged downstream of the current monitoring points for Badgerys Creek. It also appears the site will discharge to an unnamed creek to the West of the project. As such current baseline data and proposed surface water monitoring is inadequate.	Figure Three, Figure Eight, Section 3.6, Section 4.2.3 Only clean water is permitted to flow from the site.
• a detailed description of the surface water management system on site including the: ○ clean water diversion system; ○ erosion and sediment controls; ○ dirty water management system; and ○ water storages, including the area, depth and capacity of any in-pit sumps;	Discussions with EPA and DPIE - Water to determine the controlled discharge program need to be finalised.	Section 4.2 Only clean water is permitted to flow from the site. No EPL approval to discharge will be sought at this stage.
• Detailed plans, including design objectives and performance criteria, for: ○ reinstatement of drainage lines on the rehabilitated areas of the site; and ○ control of any potential water pollution from rehabilitated areas of the site;	See Section 5.3 – Please consult with the EPA to finalise the EPL. Satisfied – Section 5.3.	Section 3.6, Section 4.2.3 Only clean water is permitted to flow from the site.
• Performance criteria for the following, including trigger levels for investigating any potentially adverse impacts on: ○ the water management system;	• See Section 5.4 – Finalise the industrial process water and EPL criteria.	No industrial water will be used on site. No EPL approval to discharge will be sought at this

Relevant Consent Condition	Comment (from Appendix A)	Where Addressed in this Report
○ surface water quality in creeks and other water bodies that could potentially affected by the project (including Badgerys Creek and Badgerys Creek tributary);	• See Section 5.4 – Further monitoring needs to be undertaken to establish the baseline health of Badgerys creek.	stage. Section 4.2.4, Section 4.5
○ the stream health, vegetation health and channel stability of water bodies that could potentially affected by the project;	• See Section 5.4 – The proposed monitoring locations for stream health are inadequate as Figure 4 indicates discharges will occur beyond the proposed downstream monitoring location.	Figure Three, Figure Eight, Section 4.4, Section 4.5 Only clean water is permitted to flow from the site.
• A program to monitor and report on:		
○ Any surface water discharges	See Section 5.5 – Any discharges including those from Sediment Dam 3 must be monitored.	Figure Three, Figure Eight,, Section 4.5
○ the effectiveness of the water management system;	See Section 5.5.2 – The proposed monitoring locations are inadequate as Figure 4 indicates discharges will occur beyond the proposed downstream monitoring location.	Only clean water is permitted to flow from the site.
○ the quality of water discharged from the site to the environment;	See Section 5.5.2 – Liaise with EPA regarding EPL requirements.	No EPL approval to discharge will be sought at this stage.
○ surface water flows and quality in local watercourses; and	See Section 5.5.2 – See above regarding monitoring locations.	
○ the stream health, riparian vegetation health and channel stability of creeks and other water bodies that could potentially affected by the project; and	See Section 5.5.2 – See above regarding monitoring locations.	
A plan to respond to any exceedances of the performance criteria, and mitigate and or offset any adverse surface water impacts of the project; and	See Section 5.5.3 – Please include a plan to respond to any exceedances of the performance criteria and mitigate and/or offset any adverse surface water impacts of the project.	Section 9.0

Relevant Consent Condition	Comment (from Appendix A)	Where Addressed in this Report
Other Comments		
Please hyperlink any referenced documents so that the SWMP may be read as a standalone document.		Until final documents are approved by DPIE hyperlinks are unable to be provided.
Please append consultation with the EPA and DPIE Water.		Annexure to this report- Water Management Consultation and Correspondence
Please update table of contents.		Table of Contents

The Plan was submitted to DPIE-Water and the following comments were received (see *Appendix E*).

Table 4. ***DPIE-Water Comments from Correspondence Dated 19/10/2020***

Comment	Where Addressed in this Report
The following updates be included in the next revision of each plan (no later than December 2020) and that the revised plans be submitted to the department for approval.	This Report
Soil and Water Management Plan (SWMP) The proponent shall update the management plan to align with the conditions of the most recent modification and include the following: **1** Include written evidence that the approved suitably qualified person, Ms O'Brien, either prepared or reviewed and approved the Soil and Water Management Plan.	See Site Contacts Table Revision Table located after the Table of Contents
2 Include written evidence that Liverpool City Council have had the opportunity to comment and/or give feedback on the SWMP.	Table 5 and Appendix F
3 Include additional measures/details to satisfy the following conditions: a. all existing Water Access Licences and potential Water Access Licences, including information on the relevant Water Sharing Plan and Water Sources; and	Section 2.0
b. any off-site water transfers, including those described in	Section 2.2.3, Appendix G & Appendix H
4 Detail all measures that will be implemented to minimise clean water use on site.	Section 5.3 & Section 5.5
5 Badgerys Creek downstream monitoring location is to be relocated further downstream to more accurately capture potential impacts of the project activities.	Figure Three and Figure Eight
6 Surface water monitoring locations and baseline water quality testing of South Creek are to be implemented, as has been done for Badgerys Creek.	Section 4.5, Figure Three and Figure Eight
7 Include the depths of all water storages.	Table 8
8 Baseline data for riparian vegetation and channel morphology are to be collected as soon as practicable and appropriately detailed response actions are determined.	Noted Table 20

Comments from Liverpool Council were also received via email (see *Appendix F*) on the 28th October 2020 and are summarised below.

Table 5. ***Liverpool Council Comments from Correspondence Dated 29/10/2020***

Comment	Where Addressed in this Report
Please note that Council has reviewed the submitted Soil and Water Management Plan (SWMP) for Badgerys Creek Quarry and Brick Making Project (MP10_0014) and advises the following: <u>Groundwater Management</u> 1. It is noted that Condition 23 of the approval required the SWMP to include a Groundwater Management Plan that addressed specific criteria. However, VGT Environmental Compliance Solutions Pty Ltd indicated that the Groundwater Management Plan would be provided as a separate document. This approach appears to be inconsistent with the condition of consent which requires the SWMP to comprise both the Surface Water Management Plan and Groundwater Management Plan.	This Report
<u>Wastewater Management</u> 2. Section 2.2.1 of the SWMP refers to requirements applicable to the operation of wastewater treatment and effluent irrigation systems at the site. VGT Environmental Compliance Solutions Pty Ltd indicated that approval requirements for any upgrades to the wastewater treatment system will be investigated during the detailed design of the wastewater treatment system. Whilst approval requirements for the operation of the onsite sewage management system were outlined, consideration was not given to the installation requirements for the systems. Under Section 68 of the *Local Government Act 1993,* approval is required to install, construct or alter a waste treatment device and operate a system of sewage management at the premises. "Operate a system of sewage management" means hold or process, or re-use or discharge, sewage or by-products of sewage (whether or not the sewage is generated on the premises on which the system of sewage management is operated). In accordance with the Liverpool Development Control Plan 2008, a new system must be installed where the	Section 0

Comment	Where Addressed in this Report
existing system does not have adequate treatment capacity for all potential flows. It should be noted that sewage pump-out facilities are not supported by Council. The Application must be supported by a wastewater report prepared by a suitably qualified and experienced environmental or wastewater consultant to identify the site area available for development and determine if on-site effluent disposal is feasible when considering potential risks to public health and the environment. The detailed wastewater report shall be prepared by an Environmental Scientist or Engineer with a minimum of a bachelor's degree qualification and extensive industry experience within an on-site sewage management context. Note: There is currently no certification body for this field. The Applicant is encouraged to contact Council to discuss these requirements in further detail.	
<u>Referral to NSW EPA for Review and Comment</u> The proposed development is a scheduled activity under the *Protection of the Environment Operations Act 1997* and subject to an existing EPL issued by the NSW EPA. It is requested that the NSW EPA reviews the SWMP to determine that the proposed development is capable of being operated in an environmentally satisfactory manner consistent with the current EPL. Sampling and analysis methods must comply with the NSW EPA Approved Methods for the Sampling and Analysis of Water Pollutants in NSW dated 2004. The proposed discharge criteria for the sedimentation basins include a pH between 6.5 and 8.0 and turbidity less than 150 NTU. It is strongly recommended that water quality criteria are based on the document titled 'Managing Urban Stormwater: Soils & Construction' published by LandCom dated 2004. In this regard, the water quality discharge criteria for turbidity NTU must equal less than 50 mg/L Total Suspended Solids (TSS). If NTU is to be used in place of TSS, a statistical correlation which identifies the relationship between NTU and TSS must be established to the satisfaction of the NSW EPA.	This Report will be forwarded to the EPA for comment. Section 4.5.2 Section 4.4

1.7. Groundwater Consultation

A draft copy of the original Water Management Plan (Hyder Consulting Pty Ltd, 11 April 2013) was submitted to EPA and DoI Water, with feedback provided by DPIE. Telephone consultation was undertaken by Hyder with representatives from OEH and NOW to support the development of the Plan.

A previous draft plan has been submitted the DPIE post approval and comments were provided. An amended draft plan was submitted in August 2019 and further comments were in turn received from DPIE. The table below summarises these comments relevant to groundwater management of the Site that require actions and where addressed in this report.

Table 6. ***DPIE Post Approval Environmental Management Plan Comments-2019***

Relevant Consent Condition	Comment (from Appendix A)	Where Addressed in this Report
(iii) Groundwater Management Plan that includes: groundwater assessment criteria, including trigger levels or investigating any potentially adverse groundwater impacts; and	Not Satisfied	Section 8.0, Section 9.0
a monitoring program to manage potential impacts, if any, on any alluvium and associated surface water source near the proposed extraction area that includes: • monitoring of groundwater inflows into the quarry from the quarry face or floor, or into any in-pit sumps; • monitoring the impacts of the project on baseflows to Badgerys and South Creeks and their tributaries; • identification of a methodology for determining exceedances of the assessment criteria;	See Sections 6 to 9 – Further details of the proposed monitoring program required. The Department recommends a greater frequency monitoring then annually. Not Satisfied	Section 7.0

Relevant Consent Condition	Comment (from Appendix A)	Where Addressed in this Report
Other Comments		
Please hyperlink any referenced documents so that the SWMP may be read as a standalone document.		Until final documents are approved by DPIE hyperlinks are unable to be provided.
Please append consultation with the EPA and DPIE Water.		Appendix E
Please update table of contents.		Table of Contents

The Plan was submitted to DPIE-Water and the following comments were received (see *Appendix E*).

Table 7. ***DPIE-Water Comments from Correspondence Dated 19/10/2020***

Comment	Where Addressed in this Report
The proponent shall update the management plan to align with the conditions of the most recent modifications and include the following:	
1. Detail groundwater inflow volumes and the methodology used to calculate them for all current and proposed pits and how the proponent will ensure that the approved water access licence shares are adequate for all pits.	Section 7.2
2. Detail groundwater quality baseline data and associated trigger levels.	Section 7.4, Section 7.5
3. Ensure that groundwater sampling and reporting includes the same suite of analytes (more is also acceptable) as the surface water program.	Section 7.4, Section 7.5

2.0 Statutory Requirements and Guidelines

2.1. Environmental Planning and Assessment Act 1979

The Mod 2 project was declared a 'major development' under the then provisions of Part 3A of the Environmental Planning and Assessment Act 1979 (EP&A Act) and State Environmental Planning Policy (Major Development) 2005.

An Environmental Assessment for both Concept Plan and Project Application was approved in September 2011 and was made subject to Conditions of Approval issued by the DoPI on 27th September 2011. This plan addresses Condition 23 of the Conditions of Approval as modified (Mod 2) on 5th May 2018.

Part 3A (Major Infrastructure and Other Projects) of the EP&A Act was repealed by the NSW Environmental Planning and Assessment Amendment Act 2011 (Part 3A Repeal Act) in October 2011.

Under the Part 3A Repeal Act, projects deemed to be transitional Part 3A projects continue to be subject to Part 3A of the EP&A Act. The definition of transitional projects includes certain projects that were the subject of an existing approval under Part 3A.

This applies to Modification 3 and 4 because there is an existing Project Approval granted under Section 75J of Part 3A of the EP&A Act.

The transitional arrangements in the EP&A Act were repealed by the Environmental Planning and assessment Bill 2017. This moved transitional Part 3A projects to the current State significant development and State significant infrastructure pathways, and applications to modify such projects can no longer be made under Section 75W. This modification application has been made within the transitional timeframe and is not affected by the above arrangements.

The quarrying and brick making operations will continue to be subject to the provisions of the EP&A Act for any subsequent changes or modifications to the operations. Additionally, the operations will need to be able to demonstrate compliance against the current Conditions of Approval issued under the provisions of the EP&A Act.

2.2. Water Management Act 2000 and Water Management (General) Regulation 2018

The Water Management Act 2000 No 92 (WM Act) is intended to ensure that water resources are conserved and properly managed for sustainable use, benefiting both present and future generations.

The Water Management (General) Regulation 2018 (The Regulation) specifies procedural, technical and licence requirements under the Water Management Act 2000, as well as the functions and powers of water supply authorities.

2.2.1. Licencing and Approvals

Water sharing plans (WSP) prepared in accordance with the WM Act include rules for protecting the environment and administrating water licencing and trading.

The Water Management (General) Regulation 2018 (The Regulation) affords certain exemptions from licencing for Excluded Works.

Under Schedule 1 Excluded Works, Clause 3 states:

> *'Dams solely for the capture, containment and recirculation of drainage and/or effluent, consistent with best management practice or required by a public authority (other than Landcom or the Superannuation Administration Corporation or any of their subsidiaries) to prevent the contamination of a water source, that are located on a minor stream.'*

Exemption from licencing for Excluded Works is detailed in Schedule 1, Part 1, Clause 12 which states:

> *'(1) Any landholder—in relation to the taking of water from or by means of a work referred to in item 1, 2, 3, 4, 6, 7 or 9 in Schedule 1 that is situated on the land, for the purposes and in the circumstances specified in Schedule 1 in respect of the work.'*

Sediment basins to be constructed on the site, to comply with the Enforceable Undertaking (see *Section 2.2.3*) are for the purpose of the capture, containment and recirculation of drainage. They are consistent with the definition of excluded works and are exempt from licensing.

The water held by the pits, although greater than the Harvestable Rights, (as discussed in Section 2.2.2) has been exempt from licensing as agreed with NRAR in the Enforceable Undertaking (see Section 2.2.3). Pit water will be transferred to the Western Sydney Aerotropolis (WSA) in accordance with the Dewatering Infrastructure Plan (condition 23A of consent) and the Dewatering Management Plan (condition 23B).

All existing farm dams and Sediment Dams 1 to 3 were constructed prior to 1 January 1999 and therefore, do not need to be licenced according to DPI Water under the Water Management Act 2000. This is confirmed through inspection of aerial photography from 1986.

Plate 1. Google Earth Pro Aerial Imagery from 31st December 1984

The Badgerys Creek Mine is in the South Creek and Badgerys Creek catchments and has a groundwater water access licence (WAL) issued under the WM Act (WAL 24346). This permits the potential take of groundwater from seepage within the pit excavations. Test Bore licences, for the eight monitoring bores installed in 2019, are not required in accordance with Part 1 of Schedule 4 of the Water Management (General) Regulation 2018 that provides exemptions from access licencing for certain aquifer interference activities.

From a surface water perspective, the need for the following other licensing has been assessed for the Mod 3 and 4 Project:

- Environmental Protection Licence Variation (EPL) from the EPA for site discharges;
- Approval from DPI Water (NRAR) to construct the proposed sediment basins and future extraction pits; and
- Licensing required by Liverpool City Council to operate wastewater treatment and effluent irrigation systems. The need for licencing of any upgrades to the wastewater treatment system will be investigated further during detailed design of the wastewater treatment system and any necessary licences obtained prior to the use of these systems.

The brick manufacturing operations have not recommenced, and the current wastewater treatment has sufficient capacity for the small number of staff expected on site for the proposed rehabilitation and mining operations. Prior to commencement of the manufacturing facility, PGH will engage a suitably qualified wastewater consultant and provide a separate application to Council for any upgrades to the wastewater treatment system.

2.2.2. Harvestable Rights

Harvestable rights orders made by the Minister under section 54 of the WMA give a landholder the right to capture 10% of the average regional rainwater runoff on the land by means of a dam or dams having not more than the total capacity calculated in accordance with Schedule 1 of the orders, providing such structures are located on minor streams only (i.e. first and second order streams). This water can, in most cases, be used for any purpose. Water held over the Harvestable Rights will require a WAL unless an exemption applies or dam construction predates the WMA 2000.

The maximum capacity of a harvestable right dam(s) for a landholding is calculated by multiplying the area of the land holding by a location specific multiplier value. This is available by using the online calculator provided on the Water NSW website (http://www.water.nsw.gov.au/waterlicensing/basic-water-rights/harvesting-runoff/calculator).

The landholding owned by CSR that is attributable to the Project for purposes of harvestable rights is approximately 200 hectares (ha). Accordingly, the maximum harvestable right capacity based on application of the online calculator is 16 megalitres (ML).

Further information on how harvestable rights relates to the existing and proposed water storages at the site is provided in *Section 3.5*.

2.2.3. Enforceable Undertaking

An Enforceable Undertaking (EU) was entered with NRAR in June 2020 and requires that no surface water is retained on the site unless it is licenced to be retained. To this end, it is proposed to;

- Prevent surface water from entering the current mine voids as far as possible;
- Contain, treat and discharge captured surface water on the disturbed areas via a series of sediment dams to be constructed, when EPL criteria is met. Note, a variation to the existing EPL to discharge surface water will be sought; and
- Dewater the mine voids. Investigations into the feasibility of discharge to Badgerys Creek or transfer to the Western Sydney Airport precinct for reuse in construction are being investigated.

The Mod 3 & 4 consent conditions require the preparation of Dewatering Infrastructure Plan (see Appendix G) and a Dewatering Management Plan (see Appendix H) which outline the works to be undertaken under the EU. Both plans are required to be approved by the Secretary.

2.3. **Protection of Environment Operations Act 1997**

The objectives of the Protection of Environment Operations Act 1997 (PoEO Act) are to protect, restore and enhance the quality of the environment. Some of the mechanisms that can be applied, under the PoEO Act, to achieve these objectives include reduction of pollution at source, monitoring and reporting of environmental quality.

Section 120 deems it an Offence to pollute waters. Pollution is defined as a change in water quality.

A mine or quarry is a 'scheduled activity' under the POEO Act if it exceeds the thresholds set out in Schedule 1 of that Act. An environment protection licence (EPL) under the POEO Act must be obtained prior to the commencement of any works associated with a scheduled activity.

The Site is subject to an existing EPL (EPA Licence No. 684) which would need to be reviewed and updated based upon the proposed continued operations. An application would be made for a variation to the existing EPL to reflect the proposed future operations at the site. Clause 75V of the EP&A Act provides that, subsequent to the granting of Project Approval, an EPL cannot be refused and must be substantially consistent with the terms of Project Approval.

A variation to the EPL with regard to discharge surface water to Badgerys Creek will be sought. As is typically noted by the EPA on similar EPLs, the monitoring of overflows would not be required in times when rainfall exceeds a 90th percentile rainfall event (i.e., 48.8 mm in five days).

The purpose of including the basins into the EPL would be to ensure that any controlled discharge from the basins in lesser rainfall events would be monitored against the EPL discharge license limits for agreed parameters (typically pH, TSS and/or turbidity, and oil & grease.

2.4. State Environmental Planning Policy (Sydney Region Growth Centres) 2006

Water management procedures developed for the Site are designed to facilitate site rehabilitation objectives, which will align to development considerations identified in the Growth Centres SEPP as they become defined for the surrounding area.

These considerations would include assessing implications of development controls and objectives for:

- Environment conservation and recreation zones;
- Flood prone and major creeks land;
- Vegetation; and
- Cultural heritage landscape areas.

2.5. Western Sydney Aerotropolis- Land Use and Infrastructure Implementation plan (Stage 1)

The site also straddles two zones within the plan, Flexible Employment and Mixed Flexible Employment and Urban Land. The engineered backfilling of the quarry pits proposed in Modification 4 will provide a final landform that facilitates intensified redevelopment of the site in accordance with these zones.

2.6. Liverpool LEP

The PGH site is zoned RU1 Rural – Primary Production under the Liverpool Local Environment Plan 2008 (LEP). The objectives of this zone are:

- To encourage sustainable primary industry production by maintaining and enhancing the natural resource base.
- To encourage diversity in primary industry enterprises and systems appropriate for the area.
- To minimise the fragmentation and alienation of resource lands.
- To minimise conflict between land uses within this zone and land uses within adjoining zones.
- To ensure that development does not unreasonably increase the demand for public services or public facilities.
- To ensure that development does not hinder the development or operation of an airport on Commonwealth land in Badgerys Creek.
- To preserve bushland, wildlife corridors and natural habitat.

The existing development on the site was approved prior to the gazettal of LLEP 2008 as a 'clay extraction and brick and clay products industry'.

Works involving extractive industries are permitted by Council with consent. The Project has been granted Project Approval by the then Department of Planning and Infrastructure.

Water management objectives outlined within this report align with the objectives of the LEP with the final rehabilitated site objectives being compatible with the surrounding land fabric.

2.7. 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).

2.8. National Water Quality Management Strategy: Australia and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC, 2000)

The Australian and New Zealand Environment Conservation Council (ANZECC) 2000 Guidelines identify water quality criteria to support water use objectives and inform investigation thresholds for receiving waters.

The ANZECC guidelines have been considered in this WMP on the basis of current uses of receiving waters to inform water quality criteria through performance and trigger values for on and off site uses. These uses include:

- Stock and Domestic (off site)
- Industrial (on site)
- Aquatic ecosystems (off site).

Application of water use objectives have been used to inform the most sensitive water use for the site, and thereby focus on maintaining water quality to enable continued use for all objectives.

In addition, baseline water quality data has been obtained and where relevant, used to develop water quality criteria specific to the receiving waters.

3.0 Catchment Description

3.1. Geology

The geology of the Site comprises the Wianamatta Group. This Group comprises Bringelly Shale, which is mined within the Site (AECOM, 2010).

The Wianamatta Group extends to a depth of up to 110 m within the southern Sydney Basin and is underlain by, Hawkesbury Sandstone which is known to contain significant amounts of groundwater in some parts of the Sydney Basin. According to AECOM (2010) extraction activities are unlikely to impact this source of groundwater as the depth of extraction will be limited to 35 m.

The creek systems adjacent to the Site (Badgerys Creek and South Creek) are flanked by Quaternary alluvial deposits comprising medium grained sands, clays and silts.

3.2. Hydrogeology

The Site is underlain by the Bringelly Shale. Bringelly Shale is typically characterised by low permeability and groundwater velocities. Groundwater associated with the Wianamatta Group is characteristically saline due to its formation within a marine environment and is generally unsuitable for extraction and use.

Groundwater flow within the alluvial sediments flanking Badgerys Creek and South Creek adjacent to the Site are highly responsive to rainfall and stream flow (AECOM, 2010), thus stringent water management controls are required within these areas.

3.3. Groundwater Sources

There are three major sources of groundwater in the site that require managing on the site.

3.3.1. Alluvial Materials Adjacent to Badgerys Creek and South Creek

Alluvial sediments are present on the east and west of the Site and are likely to contain higher quantities of groundwater when compared to shale units. These alluvial deposits are important in the maintenance of local groundwater dependent ecosystems and base flows for these creek systems. There is potential for these water sources to be impacted on by excavation works in Pit 4 and Pit 5. This area was the subject of the Alluvial Aquifer Assessment (*Section 7.5*).

3.3.2. Bringelly Shales

The Bringelly Shale unit within the Wianamatta Shale Group is the source of clay and shale materials to be excavated for brick-making purposes. Characterised by low permeability this unit is located across the majority of the site and shows limited localised occurrence of groundwater within the shale units.

3.3.3. Deep Groundwater

Located greater than 100m below the surface of the Site in the Hawkesbury Sandstone geological unit this source of groundwater is unlikely to be intercepted or impacted upon. No controls are proposed for management of the groundwater associated with this geology as the maximum depth of excavation is approximately 35m.

3.4. Overview of Regional Surface Water Catchments

The Site is located within the South Creek sub-catchment which is part of the greater Hawkesbury- Nepean catchment area. The South Creek sub-catchment covers an area of 620 km² and is mostly made up of small rural farms, some light industrial and commercial and residential development. The portion of South Creek sub-catchment in the Liverpool LGA includes three major creeks; Kemps Creek, South Creek and Badgerys Creek. The main issues affecting the South Creek sub- catchment include loss of vegetation, poor water quality and high soil salinity.

South Creek is located approximately 300 metres to the east of the south eastern corner of the site and flows in a northerly direction. Land along the eastern portion of the Site is contained within the South Creek sub-catchment. South Creek is an intermittent creek of average health and has a small tributary in the eastern portion of the Site, named South Creek Tributary. South creek is characterised by frequent erosion and high abundance of weed species along the creek edge. The creek provides a source of water supply for cattle which graze on the eastern portion of the Site (AECOM, 2010).

Badgerys Creek is a permanent stream located along the western perimeter of the Site that is also located within the South Creek sub-catchment. The western property boundary of the Site adjoins Badgerys Creek and a small tributary of Badgerys Creek. Badgerys Creek is reported to be of average health, characterised by scattered erosion and high abundance of weed species (ERM, 2002).

3.5. Harvestable Rights and Water Storages

The maximum harvestable right capacity for the site based on application of the online calculator is 16 megalitres (ML).

All existing farm dams and Sediment Dams 1 to 3 were constructed prior to 1 January 1999 and therefore, do not need to be licenced according to DPI Water under the Water Management Act 2000. This is confirmed through inspection of aerial photography from 1986. The approximate water storage capacity in the existing pits, basins and farm dams is provided in *Table 8*.

Existing water storages within the extraction pits have been created as a by-product of the material extraction process. With regard to the Enforceable Undertaking, the pit voids are considered by NRAR to contain more than the harvestable rights and must be dewatered as agreed in the EU or licenced.

Table 8. ***Existing Water Storages within the Project Site***

Water Storage	Water Storage Capacity (ML)	Maximum Depth of Water Storage* (m)
Pit 1	1,590	38m RL
Pit 2	476	36m RL
Pit 3	236	42m RL
Sediment Dam 1	16.8	58m RL
Sediment Dam 2	14.7	56m RL
Sediment Dam 3	19.7	54m RL
Small Farm Dam (NE of Sediment Dam 1)	~4	59m RL
Small Farm Dam (N of Sediment Dam 3)	~5	54m RL

*From Crossmuller survey-Ref. 5

3.6. Topography and Surface Drainage

The site slopes naturally away from the centre of the site to the east towards South Creek, and to the west and north west towards Badgerys Creek. Areas of higher elevation are located within the central (65 m AHD) and southern (85 m AHD) portions of the site, while low points are found in the north western and south western portions of the site (50 m AHD), and on the eastern portion (55m AHD). Several existing dams are located across the site, which are used as sediment basins for surface runoff (*Figure Two)*.

Flows entering South Creek from the existing site comprise:

- Surface run-off from the vegetated undisturbed south eastern portion of the site; and
- Overflow of Sediment Dam 3 via an ephemeral drainage line and the undisturbed areas to the north of Sediment Dam 3 used for agricultural purposes.

Flows entering Badgerys Creek from the existing site comprise:

- Surface run-off from the area of land used for agricultural purposes; and
- Overflow via ephemeral drainage channel from Sediment Dam 1, which in turn is fed from Sediment Dam 2 overflow, which receives run off from site features described in *Table 9.*

Rehabilitation of the Western Stockpile, undertaken in March 2006 has minimised stockpile run off into Badgerys Creek, an action measure prescribed in the SWMP (ERM, 2002). All other surface runoff is contained within the site.

3.7. Existing On-Site Water Catchments

These are outlined in *Table 9* below and shown in *Figure Three*.

Table 9. ***Existing On-Site Water Catchment Areas***

Water Storage Area	Catchment Area	Catchment Description
Sediment Dams 1 and 2	17.3 Hectares (both dams) 10.2 Hectares (Sediment Dam 1)	*Clean Water* Sediment Dam 1 collects runoff from the brick product storage area, gate house, pallet storage area and overland flow. Sediment Dam 1 spills to Sediment Dam 2 in overflow events, which in turn spills into Badgerys Creek via an ephemeral drainage line.
Sediment Dam 3	17.0 Hectares	*Clean Water* Collects overland runoff from the south and west of the dam, as well as runoff from the brick plant roof located to the centre of the site. Overflow from Sediment Dam 3 will enter South Creek via an ephemeral drainage line.
Pit 1	43.8 hectares	*Dirty Water* Runoff is collected from a portion of the raw materials stockpile, the waste and overburden stockpiles to the north of the pit, and the heavy vehicle storage area.
Pit 2	7.2 Hectares	*Dirty Water* Run off is limited to quarrying area within Pit 2 and stored in a localised basin.
Pit 3	6.1 Hectares	*Dirty Water* Run off is limited to the quarrying area within the Pit 3 and stored a localised basin.

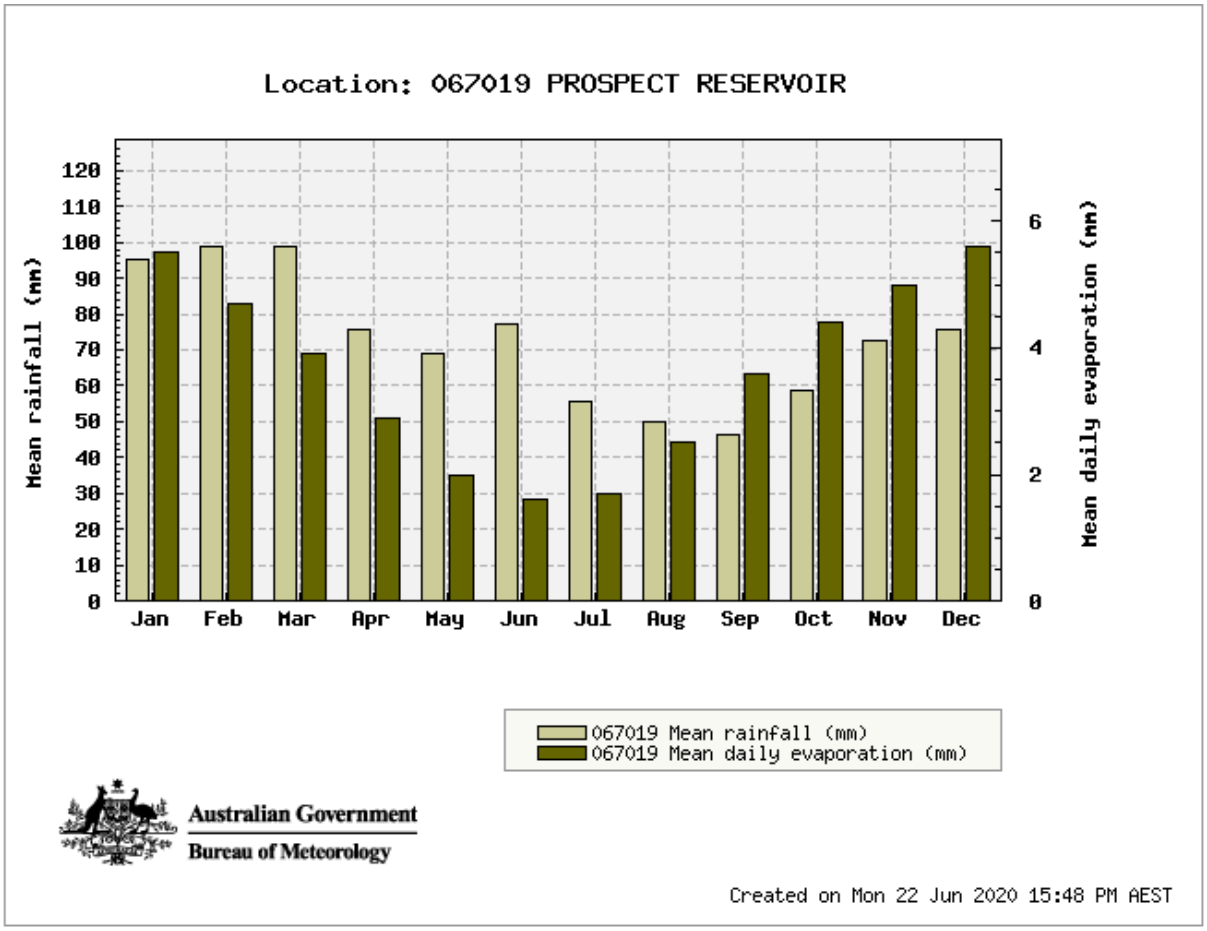
3.8. Rainfall and Evaporation

A summary of average monthly rainfall and evaporation rates for Prospect reservoir (Station Number 067019), located approximately 13km from the site is provided in *Graph 1.* Further details of water balance modelling are presented in *Section 5.0*.

Rainfall

Mean monthly rainfall data for the Prospect reservoir station (years 1887 to 2020) shows relatively stable rainfall all year round, with summer months typically wetter (approximately 70mm – 100mm per month) than the winter months (50mm – 70 mm per month).

Graph 1: Mean Rainfall and Evaporation at Station 067019 from 1887 to 2020 (Source: www.bom.gov.au)



Evaporation

Data in *Graph 1* shows a high range of evaporation throughout the year, with winter retaining more water (approximately 30 – 50 mm per month lost through evaporation) than the summer months (approximately 160 – 200 mm lost per month). There is a potential for net loss of rainfall across the site during the summer and early autumn months.

4.0 Surface Water Management Plan

4.1. Introduction

The water management actions presented in this section build upon actions included in an existing soil and water management plan for the site prepared by ERM (2002) which was subsequently updated by AECOM (2010) as part of the environmental assessment for expansion of quarrying operations on the site.

The progressive expansion of the site operations will result in changes to site drainage over the life of the project. The management actions to be implemented throughout the operational phases of the project have been developed to account for progressive changes in storage, morphology and water flows on site.

Sustainable water management actions have been developed for the site which is based around separation of clean and dirty water flows, capturing stormwater runoff for use in the quarry process, dust suppression and environmental controls. Further opportunities will also be pursued for re-use of water to minimise onsite potable water use after gaining appropriate water licences to use this water. All management actions contained within this Plan are consistent with the legislative and best practice requirements identified in *Section 2.0.*

4.2. Surface Water Management System

An overview of the onsite surface water management system consisting of clean water diversion, erosion and sediment controls and water storages is outlined in *Sections 4.2.1* to *4.2.3*. A summary of actions in accordance with Site surface water flows, presented in *Figure Eight* and is detailed in *Table 12*.

4.2.1. Clean Water Diversion System

Clean water onsite is defined as runoff that has not come into contact with any disturbed area of the site. As detailed in *Table 12*, the objective of site water management with respect to clean water is to minimise disturbed areas within the site and separate these areas from undisturbed by manipulating ground contours and implementing controls to divert clean water off site while diverting runoff from disturbed areas to the proposed sediment dams.

4.2.2. Erosion and Sediment Controls

All erosion and sediment controls documented in this Plan have been developed in accordance with Managing Urban Stormwater: Soils and Construction (Landcom, 2004) and Volume 2E Mines and Quarries (DECC, 2008) (the Blue Book). The intent of erosion and sediment controls for the site is to minimise the mobilisation of sediment onsite, and where this is not achievable, to reduce sediment transport around and off the site. Priority areas for the application of erosion and sediment controls around the site are discharge points to local watercourses (Badgerys Creek, Badgerys Creek Tributaries, South Creek and South Creek Tributaries), disturbed downslopes, and the integrity of natural and formalised drainage channels responsible for the movement of clean and dirty water.

All disturbed long-term stockpile areas and disturbed areas outside access roads will be seeded to ensure establishment of groundcover in accordance with Blue Book requirements. As required, erosion and sediment control measures will be maintained to ensure effectiveness and promote ongoing compliance with the EPL.

4.2.2.1. *Soil Characterisation*

The catchment area and dam volumes for the site were estimated using the NSW Managing Urban Stormwater handbook, also known as the Blue Book (see *Section 4.2.3*). Several assumptions have been made as listed below.

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 D.*

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 10. *Constraints and Characteristics*

Constraint/Opportunity	Value
IFD:2-year, 6 hour storm	8.02 (from the BOM IFD data)
Slope Gradients	Low to Moderate (Average 5%)
Soil Erodibility	High (assumed)
Calculated Soil Loss	Up to 253 tonnes/Ha/yr depending on particular mine slopes.
Soil Loss Class	3
Soil Texture Group	Type D
Soil Hydrological Group	D
Runoff Coefficient	0.69 (Soil Hydrological Group D)

4.2.3. Dam Catchments, Water Storages and Discharge

To date, the activities at the facility have been limited and the opportunity for interactions with the environment were limited. There are a number of water management structures within the operational boundary of the Site. These structures consist of Pit 1, Pit 2, Pit 3, three sedimentation Dams and two farm dams. Due to the complexity of the works proposed on the site, the surface water management system will consist of a number of phases (as described in the RTS Mod 3- October 2019) to accommodate the development elements as they proceed.

4.2.3.1. *Phase 1 Works (Years One to Six)*

As a result of an Enforceable Undertaking and discussions with Natural Resources Access Regulator (NRAR), Pits 1, Pit 2 and Pit 3 will not be permitted to receive surface water from the site. As a result, surface water received over the disturbed areas will require diversion to several sediment dams proposed to be constructed in strategic locations, utilising naturally occurring depressions where possible. Options for the sediment basin locations are shown in *Figure Eight* and will be constructed in accordance with Blue Book requirements for a 5 day, 90th% design storm. The system will allow for capture of surface water over the disturbed areas in primary sedimentation dams and treatment of the captured water in a final sediment dam prior to discharge to Badgerys Creek. Drains designed for a 1 in 10-year design storm will be constructed, where required, to convey surface water to the sediment dams and to transfer between dams. Where topography does not permit gravity feeding of water transfers between dams, water will be pumped overland via temporary pipes.

Concurrently Pit 2 and Pit 3 will be dewatered into Pit 1 over seven and three weeks respectively. Pit 1 will also commence dewatering by pumping water to the WSA site via a pipeline installed under Badgerys Creek, up to 10ML per day. Alternatively, water from Pit 1 could be discharged separately or concurrently, when EPL quality parameters are met, into Badgerys Creek at a rate of 100,000L/hr 24 hours a day seven days a week. It is expected to take one to three years to dewater Pit 1.

Extraction of Pit 3 will recommence initially, and captured surface water will be pumped into the sediment dam system to be eventually discharged to Badgerys Creek. Extraction and backfilling operations will be undertaken concurrently where possible. Once the Pit 3 backfilling operations are completed and the formerly disturbed surface has sufficient coverage (vegetation or otherwise sealed), surface water will be permitted to enter South Creek via overland flows.

When commenced, backfilling of Pit 2 is expected to have a duration of approximately 4 years. Surface water captured over this Pit 2 disturbed area will be captured in the void and pumped into the final sedimentation dam for treatment prior to discharge. As the void backfilling nears completion, the surface water will be diverted directly to the final sedimentation dam until the formerly disturbed surface has sufficient coverage (vegetation or otherwise sealed) to minimise entrainment of sediment. Surface water may then be diverted via overland flow to Badgerys Creek.

When commenced, backfilling of Pit 1 is expected to have a duration of two to seven years depending on VENM availability. Surface water captured within the former void during backfilling operations will be pumped to the final sedimentation dam for treatment and

discharge in accordance with EPL conditions as required. As the backfilling operation of Pit 1 is completed, the surface water will be diverted directly to the final sedimentation dam until the formerly disturbed surface has sufficient coverage (vegetation or otherwise sealed) to minimise entrainment of sediment. Surface water may then be diverted via overland flow to Badgerys Creek.

Pit 1 and Pit 2 areas are then available for future development.

It is likely that TfNSW would realign and extend Martin Road southwards through the site during this phase (see *Figure Four* to *Figure Seven*). If extraction from Pit 3 is not complete prior to the road construction, an underpass to allow haulage of extracted material and transfer of sediment laden water captured in the pit will be considered. Alternatively, the pit water may be treated and discharged to South Creek should the EPL be varied to allow an additional discharge point.

4.2.3.2. *Phase Two (Seven to Ten Years)*

Extraction from Pit 3 will continue eastward whilst backfilling of the Pit commences where mining is complete in the west. Surface water from the Pit 1 and Pit 2 catchments should be effectively clean water as the rehabilitation works are completed. Overland flows would then be restored to Badgerys Creek from these catchments.

The sediment dam infrastructure constructed in Phase 1 will largely be retained to assist with the management of surface water collected over the raw material stockpile area.

4.2.3.3. *Phase Three (Eleven to Thirteen Years)*

Extraction of Pit 3 has been completed in Phase 2 and only backfilling activities in Pit 3 will continue. By the end of this phase, Pit 3 backfilling and rehabilitation will be completed. Surface water collected on the site would be considered to be clean and may be diverted directly to South Creek as overland flows.

Pit 3 area is available for future development.

As stated previously, the sediment dam infrastructure constructed in Phase 1 will largely be retained to assist with the management of surface water collected over the raw material stockpile area and discharged into Badgerys Creek via the EPL.

4.2.3.4. *Phase Four (Fourteen Years Onwards)*

The backfilling and rehabilitation operations have been completed in the previous phases.

The sediment dam infrastructure constructed in Phase 1 will continue to assist with the management of surface water collected over the raw material stockpile area.

4.2.3.5. *Proposed Water Storages*

It is proposed to construct a number of Sediment Dams designed to capture the 90th percentile 5-day storm event in order to manage the surface water on the disturbed area whilst preventing surface water from entering the pit voids. The pit voids would be dewatered separately. Several options are being considered (as shown in *Figure Eight*) but the intent is to capture dirty water in primary dams located in strategic locations and then either gravity feed or pump the water to a final sediment dam located in the north western portion of the site for treatment to remove sediment. Water that meets the EPL criteria would then be released into Badgerys Creek at a controlled rate with adequate erosion protection to the discharge point.

Table 11. *Proposed Water Storages within the Project Site*

Water Storage	Water Storage Capacity (ML)	Volume required for Design Storm Event (5-day 90th % ile) (ML)
Pit 1	Nil (once dewatered captured water to be transferred to the Sediment Dams)	9
Pit 2	Nil (once dewatered captured water to be transferred to the Sediment Dams)	3
Pit 3	Nil (once dewatered captured water to be transferred to the Sediment Dams)	2
Sediment Dam1 (clean water)	16.8	Not Required
Sediment Dam 2 (clean water)	14.7	Not Required
Sediment Dam 3 (clean water)	19.7	Not Required
Small Farm Dam 1 (NE of Sediment Dam 1) (clean water)	~4	Not Required
Small Farm Dam 2 (N of Sediment Dam 3) (clean water)	~5	Not Required
Sediment Basin A	15	9.7
Sediment Basin B	7.5	Nil

Note: Pit volumes obtained from Crossmuller Technology Report 2017.

As can be seen from the table above, the proposed sediment basins have sufficient capacity to contain the design storm including transfer of water captured in the Pits to the sediment basins during backfilling operations.

Table 12. ***Water Management Systems Summary***

Site Feature/ Description	Description	Clean Water Management	Erosion and Sediment Control	Water Storage	Comment
Pit 1	Collects runoff from incident rainfall collected over the dam surface and immediate void slopes. Will be dewatered and backfilled for future development.	Clean water management not required during the dewatering and backfilling phase as all catchment water is runoff from disturbed areas. Once final contours have been achieved and the groundcover C-Factor of 0.01 (equivalent to 70% groundcover) is achieved, the surface water received in the area is considered clean and may be diverted directly to Badgerys Creek as overland flows.	<u>Dewatering</u> Prior to dewatering of Pit 1, surface water will be diverted as far as possible around Pit 1 and directed to the Sediment Dams for collection and treatment prior to discharge as per EPL conditions. Any drains constructed to facilitate the diversion of surface water around Pit 1 are to be designed with sufficient capacity for the 1 in 10-year ARI. <u>Backfilling</u> During the backfilling phase, erosion and sediment controls will be applied to the disturbed surfaces and may include; • Installation of silt fences where appropriate • Delineating areas to be disturbed and not encroaching beyond these areas. • Drains are to be designed with sufficient capacity for the 1 in 10-year ARI. • Ensuring the groundcover C-Factor of 0.01 (equivalent to 70% groundcover) is achieved as soon as possible on rehabilitated areas. • Sediment laden water collected in the void during the backfilling phase is pumped into the sediment dams and treated prior to discharge to Badgerys Creek as per the EPL conditions.	Pit 1 will be dewatered and not used as a water storage. Dewatering will be achieved via transfer to the WSA water storage area using a dedicated above ground pipeline and/or direct discharge to Badgerys Creek when EPL conditions are met. Sediment laden water collected in the void during the backfilling phase is pumped into the sediment dams and treated prior to discharge to Badgerys Creek as per the EPL conditions. Installing infrastructure (e.g. pumping station and rising mains) for the active transport of water between Pit 1 and Sediment Dams used for water storage. Investigate reuse methods including reuse in the brick production process and offsite reuse in industry and agriculture with appropriate licencing. Inspections of water storage structures after rainfall events exceeding 25mm in a 24-hour period.	As site morphology changes over time, sustain formalised drainage pathways to water storage areas so as to minimise flow velocity and slope length, thereby reducing erosion and sedimentation potential. Where structures or systems are found not to be functioning effectively, they will be restored to ensure that they align with requirements outlined in this Plan. Regular water testing will be undertaken (as outlined in this plan) to ensure that controls are adequate and Badgerys Creek and South Creek are not adversely impacted.

Site Feature/ Description	Description	Clean Water Management	Erosion and Sediment Control	Water Storage	Comment
Proposed Disturbed Area Sediment Dam System (see Figure Eight for proposed locations and configurations)	Collects runoff from raw materials stockpile, eastern stockpile, south eastern stockpile (east and west), Pit 3 and the central stockpile.	Clean water management not required as all catchment water is runoff from disturbed area. Direct dirty water towards water storage areas and away from clean water flow paths.	Maintain stabilised diversion channels to Sediment Dams from stockpile area through the use of contour berms. Clean out/maintain pipe transporting runoff from Eastern Stockpile to Sediment Dams. Maintain contoured drainage pathways around stockpile areas (East West and central) to Sediment Dams via formalised drainage channels. Install silt fence where appropriate. Maintain stabilisation of long-term overburden and topsoil stockpiles and bunds in accordance with the Blue Book (SD 4-1). Drains are to be designed with sufficient capacity for the 1 in 10-year ARI. Delineating areas to be disturbed and not encroaching beyond these areas.	All water from disturbed areas onsite to be diverted to the Sediment Dams. Installing infrastructure (e.g. pumping station and rising mains) for the active transport of water between Sediment Dams when multiple Sediment Dams are used for water storage and treatment. Investigate reuse methods including reuse in the brick production process and offsite reuse in industry and agriculture with appropriate licencing. Inspections of water storage structures after rainfall events exceeding 25mm in a 24-hour period.	As stockpile site morphology changes over time, sustain formalised drainage pathways around stockpiles to water storage areas so as to minimise flow velocity and slope length, thereby reducing erosion and sedimentation potential. Where structures or systems are found not to be functioning effectively, they will be restored to ensure that they align with requirements outlined in this Plan. Regular water testing will be undertaken (as outlined in this plan) to ensure that controls are adequate and Badgerys Creek and South Creek are not adversely impacted.

Site Feature/ Description	Description	Clean Water Management	Erosion and Sediment Control	Water Storage	Comment
Pit 2	Pit 2 contains a sediment basin and pump out facilities. Runoff flowing to Pit 2 is currently pumped into Pit 1. Pit 2 will be dewatered to Pit 1 and backfilled for future development.	Clean water management not required during the dewatering and backfilling phase as all catchment water is runoff from disturbed areas. At the completion of rehabilitation (including revegetation), surface flows will be returned to Badgerys Creek as clean water. Once final contours have been achieved and the groundcover C-Factor of 0.01 (equivalent to 70% groundcover) is achieved, the surface water received in the area is considered clean and may be diverted directly to Badgerys Creek as overland flows.	<u>Dewatering</u> Prior to dewatering of Pit 2, surface water will be diverted as far as possible around Pit 2 and directed to the Sediment Dams for collection and treatment prior to discharge as per EPL conditions. Any drains constructed to facilitate the diversion of surface water around Pit 2 are to be designed with sufficient capacity for the 1 in 10-year ARI. <u>Backfilling</u> During the backfilling phase, erosion and sediment controls will be applied to the disturbed surfaces and may include; • Installation of silt fences where appropriate • Delineating areas to be disturbed and not encroaching beyond these areas. • Drains are to be designed with sufficient capacity for the 1 in 10-year ARI. • Ensuring the groundcover C-Factor of 0.01 (equivalent to 70% groundcover) is achieved as soon as possible on rehabilitated areas. Sediment laden water collected in the void during the backfilling phase is pumped into the sediment dams and treated prior to discharge to Badgerys Creek as per the EPL conditions.	Pit 2 will be dewatered by transfer of water to Pit 1 and not used as a water storage. Sediment laden water collected in the void during the backfilling phase is pumped into the sediment dams and treated prior to discharge to Badgerys Creek as per the EPL conditions. Installing infrastructure (e.g. pumping station and rising mains) for the active transport of water between Pit 2 and Sediment Dams used for water storage. Investigate reuse methods including reuse in the brick production process and offsite reuse in industry and agriculture with appropriate licencing. Inspections of water storage structures after rainfall events exceeding 25mm in a 24-hour period.	As site morphology changes over time, sustain formalised drainage pathways to water storage areas so as to minimise flow velocity and slope length, thereby reducing erosion and sedimentation potential. Where structures or systems are found not to be functioning effectively, they will be restored to ensure that they align with requirements outlined in this Plan. Regular water testing will be undertaken (as outlined in this plan) to ensure that controls are adequate and Badgerys Creek and South Creek are not adversely impacted.

Site Feature/ Description	Description	Clean Water Management	Erosion and Sediment Control	Water Storage	Comment
Pit 3	Collects run-off from the disturbed area in Pit 3. Pit 3 will be dewatered to Pit 1. Extraction will recommence in Pit 3 and backfilling for future development.	Clean water management not required during the dewatering, extraction and backfilling phase as all catchment water is runoff from disturbed areas. Once final contours have been achieved and the groundcover C-Factor of 0.01 (equivalent to 70% groundcover) is achieved, the surface water received in the area is considered clean and may be diverted directly to Badgerys Creek or South Creek as overland flows.	<u>Dewatering</u> Prior to dewatering of Pit 3, surface water will be diverted as far as possible around Pit 3 and directed to the Sediment Dams for collection and treatment prior to discharge as per EPL conditions. Any drains constructed to facilitate the diversion of surface water around Pit 3 are to be designed with sufficient capacity for the 1 in 10-year ARI. <u>Extraction</u> During the extraction phase water captured in the pit is pumped into the sediment dams and treated prior to discharge to Badgerys Creek as per the EPL conditions. Establishment of water storage areas and stabilisation of drainage channels prior to excavations or other soil disturbance activities within the catchment. Drains are to be designed with sufficient capacity for the 1 in 10-year ARI. Strip topsoil when moist, Handle topsoil only once. Maintain stabilisation of topsoil and overburden stockpiles and bunds in accordance with the Blue Book (SD 4-1). Treat stockpiles and bunds with surface roughening, soil surface mulching. Overburden and topsoil stockpiles are to be stabilised via vegetation or other means within 20 days of completion of construction such that a C factor of 0.01 (equivalent to 70% groundcover) is achieved. <u>Backfilling</u> Sediment laden water collected in the void during the backfilling phase is pumped into the sediment dams and treated prior to discharge to Badgerys Creek as per the EPL conditions. During the backfilling phase, erosion and sediment controls will be applied to the disturbed surfaces and may include; • Installation of silt fences where appropriate • Delineating areas to be disturbed and not encroaching beyond these areas. • Drains are to be designed with sufficient capacity for the 1 in 10-year ARI. • Ensuring the groundcover C-Factor of 0.01 (equivalent to 70% groundcover) is achieved as soon as possible on rehabilitated areas.	Pit 3 will be dewatered by transfer of water to Pit 1 and not used as a water storage. Sediment laden water collected in the void during the extraction and backfilling phase is pumped into the sediment dams and treated prior to discharge to Badgerys Creek as per the EPL conditions. Installing infrastructure (e.g. pumping station and rising mains) for the active transport of water between Pit 3 and Sediment Dams used for water storage. Investigate reuse methods including reuse in the brick production process and offsite reuse in industry and agriculture with appropriate licencing. Inspections of water storage structures after rainfall events exceeding 25mm in a 24-hour period.	As site morphology changes over time, sustain formalised drainage pathways to water storage areas so as to minimise flow velocity and slope length, thereby reducing erosion and sedimentation potential. Where structures or systems are found not to be functioning effectively, they will be restored to ensure that they align with requirements outlined in this Plan. Regular water testing will be undertaken (as outlined in this plan) to ensure that controls are adequate and Badgerys Creek and South Creek are not adversely impacted.
Sediment Dam 3	Collects overland clean water runoff from the south and west of the Dam, as well as clean water runoff from the brick making facility. Overflow from Sediment Dam 3 currently	Maintain integrity of the clean water catchment.	Delineating areas to be disturbed and not encroaching beyond these areas.	Sediment Dam 3 to contain clean water runoff from the eastern portion of the site. Inspections of water storage structures after rainfall events exceeding 25mm in a 24-hour period.	Where structures or systems are found not to be functioning effectively, they will be restored to ensure that they align with requirements outlined in this Plan.

Site Feature/ Description	Description	Clean Water Management	Erosion and Sediment Control	Water Storage	Comment
	enters South Creek via an ephemeral drainage line.				
Sediment Dams 1 and 2	Collects clean water runoff from the brick product storage area, brick making facility, gate house and overland flow. Sediment Dam 1 spills to Sediment Dam 2 in overflow events, which in turn spills into Badgerys Creek via an ephemeral drainage line. No works are proposed for this sediment Dam.	Maintain integrity of clean water catchment.	Delineating areas to be disturbed and not encroaching beyond these areas.	Initially all clean water runoff from the brick storage area, factory and undisturbed agricultural land to flow into Sediment Dam 1 & 2 and Badgerys Creek. Inspections of water storage structures after rainfall events exceeding 25mm in a 24-hour period.	Where structures or systems are found not to be functioning effectively, they will be restored to ensure that they align with requirements outlined in this Plan.
Noise Attenuation Bunds	Perimeter bunds will be established and once stabilised with vegetation, will convey clean surface water flows directly to South Creek or Badgerys Creek.	Direct dirty water towards water storage areas and away from clean water flow paths.	Establishment of water storage areas and stabilisation of drainage channels prior to excavations or other soil disturbance activities within the catchment. Delineating areas to be disturbed and not encroaching beyond these areas. Construct sediment fencing along outer edge of noise attenuation berm extending along the eastern, northern and a portion of the western and southern site Implement and maintain controls to manage runoff from access roads within the site. Establishment and regular maintenance of sediment fences to contain sediment downslope of disturbed areas in accordance with Blue Book sediment fence guidance (SD 6-8). Bunds are to be stabilised via vegetation or other means within 20 days of completion of construction such that a C factor of 0.01 (equivalent to 70% groundcover) is achieved. Drains are to be designed with sufficient capacity for the 1 in 10-year ARI.	Not applicable,	Where structures or systems are found not to be functioning effectively, they will be restored to ensure that they align with requirements outlined in this Plan.

Site Feature/ Description	Description	Clean Water Management	Erosion and Sediment Control	Water Storage	Comment
Stockpile, Access Tracks, Haul Roads and Overburden Areas	Surface water retained on these areas will be directed to the sediment basins.	Direct dirty water towards water storage areas and away from clean water flow paths.	Establishment of water storage areas and stabilisation of drainage channels prior to excavations or other soil disturbance activities within the catchment. Maintain stabilisation of stockpiles and bunds in accordance with the Blue Book (SD 4-1). Treat stockpiles and bunds with surface roughening, soil surface mulching. Overburden and topsoil stockpiles are to be stabilised via vegetation or other means within 20 days of completion of construction such that a C factor of 0.01 (equivalent to 70% groundcover) is achieved. Delineating areas to be disturbed and not encroaching beyond these areas. Establishment and regular maintenance of sediment fences to contain sediment downslope of disturbed areas in accordance with Blue Book sediment fence guidance (SD 6-8). Drains are to be designed with sufficient capacity for the 1 in 10-year ARI.	All water from disturbed areas onsite to be diverted to sediment basins. Installing infrastructure (e.g. pumping station and rising mains) for the active transport of water between Sediment Basin used for water storage. Investigate reuse methods including reuse in the brick production process and offsite reuse in industry and agriculture with appropriate licencing. Inspections of water storage structures after rainfall events exceeding 25mm in a 24-hour period.	Where structures or systems are found not to be functioning effectively, they will be restored to ensure that they align with requirements outlined in this Plan.
Brick Plant, Offices, Brick Storage Areas	Surface water retained on these areas will be directed to Sediment Dams 1, 2 or 3.	Maintain integrity of clean water catchment.	Establishment and regular maintenance of sediment fences to contain sediment downslope of disturbed areas in accordance with Blue Book sediment fence guidance (SD 6-8). Maintaining stable site access with vehicle wash-down register. Drains are to be designed with sufficient capacity for the 1 in 10-year ARI.	Initially all clean water runoff from the brick storage area, factory and undisturbed agricultural land to flow into Sediment Dam 1 & 2 and Badgerys Creek. Sediment Dam-3 to contain clean water runoff from the eastern portion of the site. Inspections of water storage structures after rainfall events exceeding 25mm in a 24-hour period.	Where structures or systems are found not to be functioning effectively, they will be restored to ensure that they align with requirements outlined in this Plan.
Undisturbed Areas (e.g. north west and east) including Farm Dams 4 and 5.	These comprise of areas to the north west and east of the site currently used for grazing.	Clean water management not required as all catchment water is runoff from undisturbed areas.	Delineating areas to be disturbed and not encroaching beyond these areas.	Inspections of water storage structures after rainfall events exceeding 25mm in a 24-hour period.	Where structures or systems are found not to be functioning effectively, they will be restored to ensure that they align with requirements outlined in this Plan.
Badgerys Creek	Receives overland flows from clean water catchments as well as the proposed controlled discharge from the site.	Maintain integrity of clean water catchment.	<u>Dewatering and Discharge</u> Delineating areas to be disturbed and not encroaching beyond these areas. Any drains constructed to facilitate the discharge of surface water are to be designed with sufficient capacity for the 1 in 10-year ARI. Discharge point to be protected from erosion through energy dissipation devices and adequate erosion protection. Discharge flows not to exceed the 1 in 10-year ARI flow rate for Badgerys Creek.	Not applicable	Regular water testing will be undertaken (as outlined in this plan) to ensure that controls are adequate, and Badgerys Creek is not adversely impacted. Where structures or systems are found not to be functioning effectively, they will be restored to ensure that they align with requirements outlined in this Plan
South Creek	Receives overland flows from clean water catchments.	Maintain integrity of clean water catchment.	Delineating areas to be disturbed and not encroaching beyond these areas.	Not applicable	Regular water testing will be undertaken (as outlined in this plan) to ensure that controls are adequate, and South Creek is not adversely impacted. Where structures or systems are found not to be functioning effectively, they will be restored to ensure that they align with requirements outlined in this Plan

4.2.4. Baseline Water Quality

Baseline water quality data has been gathered on a quarterly basis for Badgerys Creek whilst the site has been in a state of low activity. Samples have been taken in Badgerys Creek upstream and downstream of the confluence of the tributary (natural drainage line) from Pit 1 to Badgerys Creek (See *Figure Three*). The 'Confluence' had also been sampled with the intention that this was likely to be approved in the future as an EPL Discharge Point. Badgerys Creek at this location does not experience permanent flows. Water, where available for sampling, was located in isolated ponds. No discharges from Pit 1 have been undertaken and the results of the 'Confluence' site are reflective of Badgerys Creek into which it is linked. Water quality of the Pits has also been sampled periodically. The results are summarised below and have been used to assist in the establishment of performance criteria and trigger levels as discussed below. Note, the discharge point under Mod 3 and Mod 4 (the Preferred Project) is likely to be located upstream of the Confluence and upstream sampling locations.

4.2.5. Discharge of Water from Sediment Basins

4.2.5.1. *Determining Need for Discharge*

The need to discharge will be determined on the need maintain sufficient capacity for the design storm event.

4.2.5.2. *Maintaining Dam Levels*

The Sedimentation Basins will be pegged to indicate the maximum sediment level that can be contained within the dam before desilting is required. A peg will also be installed to indicate when there is insufficient capacity remaining in the dam for the design storm event.

4.2.5.3. *Treatment of Water to be Discharged*

The following outlines the procedure for preparing water for discharge from the Sedimentation Basins:

- The water in the Sediment Basins will be sampled and tested for pH and Turbidity;
- If the sampled water meets the criteria listed in *Section 4.2.5.4,* 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 dam will be treated with flocculants and/or buffers and sufficient time allowed for sediment to settle is given before additional sampling and testing is conducted;
- The above steps will be repeated until the water is of a suitable quality.
- The treatment, testing and discharge of the water may be achieved via batch treatment or continually via a suitably designed automated treatment system.

4.2.5.4. *Discharge Criteria*

The discharge criteria will be that outlined in the EPL once varied to permit discharge. The proposed concentration limits are:

- The pH is between 6.5 to 8.0; and
- Turbidity is <150NTU.

4.2.5.5. *Discharge of Water*

Once the water has been determined to be of suitable quality to discharge, the water will be pumped to an energy dissipater located adjacent to Badgerys Creek.

No concentrated flows will be permitted to leave the site. The discharge pipe 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.

The controlled discharge rate downstream from Basin C will be much lower than the rate expected by a 1 in 10-year ARI event expected in Badgerys Creek (catchment of approximately 1,670 Ha) prior to development as can be seen in the table below. Note, the soils are assumed to be hydrological group D, very high runoff potential. It should be noted that the flows will essentially be restored to the downstream environment once rehabilitation is completed.

Table 13. ***Flow Rates for 1 in 10-year storm event***

Catchment	Flow rate (cubic metres per second)
Estimated Catchment(~1,670Ha)	86*
Controlled discharge over 24 hours (estimated)	0.2

*Calculated using the Blue Book and IFD data.

4.2.6. Discharge of Water from Pits

The discharge of water from the Pits is described in the Dewatering Infrastructure Plan and the Dewatering Management Plan.

Table 14. *Badgerys Creek Baseline Water Quality*

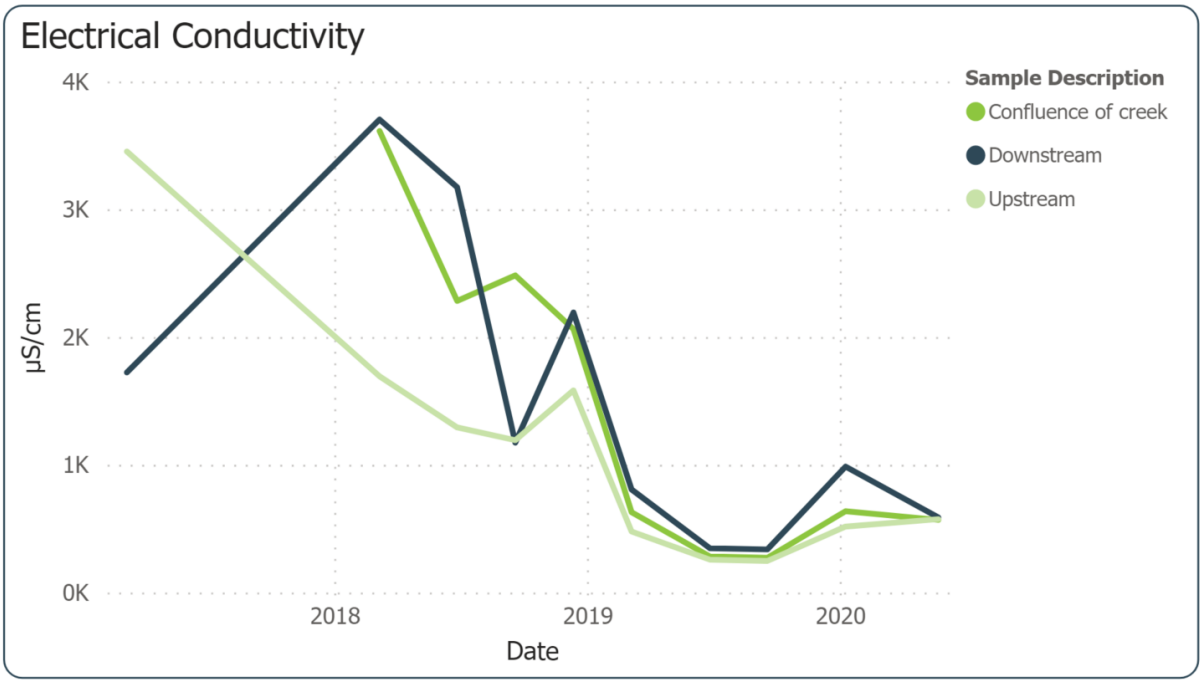
Date	Sample ID	Sample Description	Temp. (ºC)	pH	Conductivity (µS/cm)	Ammonia (mg/L	Total Nitrogen (mg/L)	Total Phosphorus (mg/L)	Dissolved Oxygen (mg/L)	NO_x (mg/L)	Reactive Phosphorus (mg/L)	Comments
2/12/2015	2320/1	Upstream	22.7	7.2	1,650	**0.25**	**2.6**	**1.12**				Not running
2/12/2015	2320/2	Downstream	23.4	7.5	**2,390**	**0.16**	**1.8**	**0.54**				Stagnant, scum, rainbow effect, casuarinas above
6/03/2017	3888/1	Upstream	21.5	7.2	**3,460**	**0.48**	**14**	**1.3**				No Visible Oil and Grease
6/03/2017	3888/2	Downstream	21.4	7.0	1,730	**0.15**	**19**	**0.4**				No Visible Oil and Grease
19/09/2017	4808/1	Tributary Confluence	17.6	8.2	1,970	**0.035**	**1.3**	<0.05	9	<0.005	<0.01	-
19/09/2017	4808/2	Upstream	-	-	-	-	-	-	-	-	-	Dry, could not sample
19/09/2017	4808/3	Downstream	13.4	7.5	**3,820**	**0.05**	**0.7**	<0.05	7.1	<0.005	<0.01	Shaded
6/03/2018	5446/1	Tributary Confluence	23.6	8.9	**3,620**	**0.068**	**5.6**	**1.3**	18.9	0.005	**0.54**	No discharge form Quarry. Greenish
6/03/2018	5446/2	Upstream	22.2	8.1	1,700	0.014	**1.1**	**0.1**	9.7	<0.005	**0.055**	Not flowing or connected
6/03/2018	5446/3	Downstream	21.7	8.0	**3,710**	0.02	**1.9**	**0.3**	10.2	0.01	**0.27**	Not flowing or connected
26/06/2018	6039/1	Tributary Confluence	7.9	7.8	**2,290**	**1.3**	**6.6**	**1.9**	6.1	<0.005	**0.05**	No flow, not discharging, algae, turbid
26/06/2018	6039/2	Upstream	6.6	7.5	1,300	0.01	**1.5**	**0.3**	8.3	<0.005	0.01	No flow, turbid, algae
26/06/2018	6039/3	Downstream	**5.9**	7.6	**3,180**	**0.082**	**3.6**	**0.07**	6.1	**0.05**	0.014	Clear, no flow, isolated pond
18/09/2018	6399/1	Tributary Confluence	15.7	8.1	**2,490**	<0.005	**1.1**	**0.3**	16	<0.005	**0.037**	Not discharging, isolated pond, very shallow, algae

Date	Sample ID	Sample Description	Temp. (ºC)	pH	Conductivity (µS/cm)	Ammonia (mg/L	Total Nitrogen (mg/L)	Total Phosphorus (mg/L)	Dissolved Oxygen (mg/L)	NO_x (mg/L)	Reactive Phosphorus (mg/L)	Comments
18/09/2018	6399/2	Upstream	14.0	6.7	1,200	**0.06**	**0.8**	**0.09**	9.6	0.01	**0.048**	Isolated pond, algae
18/09/2018	6399/3	Downstream	10.9	**6.3**	1,180	**0.29**	**1.9**	**0.07**	6.6	**0.50**	**0.03**	Isolated pond
11/12/2018	6778/1	Tributary Confluence	22.9	7.2	2,070	**0.041**	**1.9**	**0.5**	3.3	0.006	**0.48**	Most water in creek since sampling began
11/12/2018	6778/2	Upstream	22.2	7.2	1,590	0.01	**1.2**	**0.2**	5.4	0.01	**0.32**	Most water in creek since sampling began
11/12/2018	6778/3	Downstream	21.5	7.1	2,200	**0.038**	**1.5**	**0.2**	4.1	0.01	**0.3**	Most water in creek since sampling began
5/3/2019	7090/1	Tributary Confluence	24.4	7.4	636	<0.005	**0.6**	**0.1**	3.9	<0.005	**0.088**	
5/3/2019	7090/2	Upstream	22.8	7.2	485	<0.005	**0.7**	**0.2**	3.0	0.007	**0.110**	
5/3/2019	7090/3	Downstream	23.2	7.2	814	<0.005	**0.7**	**0.09**	3.9	0.007	**0.083**	
26/6/2019	7635/1	Tributary Confluence	10.7	7.1	290	**0.029**	0.4	**0.08**	7.5	0.040	**0.068**	Not flowing in from quarry
26/6/2019	7635/2	Upstream	10.4	7.1	265	0.010	0.4	**0.08**	7.1	**0.060**	**0.076**	Creek connected with plenty of water US to DS
26/6/2019	7635/3	Downstream	11.8	7.1	354	**0.025**	0.5	<0.05	6.6	**0.060**	**0.048**	
17/09/2019	8013/1	Tributary Confluence	12.1	7.1	279	0.005	0.5	**0.08**	7.4	<0.005	**0.036**	
17/09/2019	8013/2	Upstream	10.9	7.1	255	<0.005	0.5	0.05	7.1	0.006	**0.03**	
17/09/2019	8013/3	Downstream	10.8	7.1	345	**0.028**	**0.6**	<0.05	6	0.03	**0.027**	

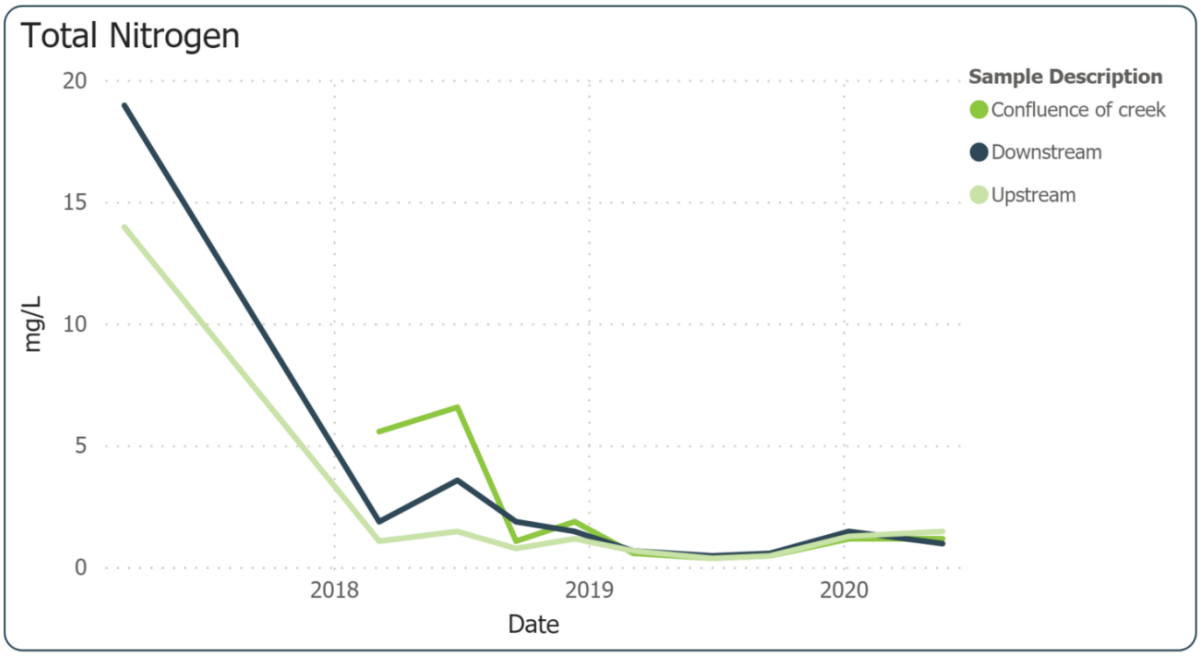
Date	Sample ID	Sample Description	Temp. (ºC)	pH	Conductivity (µS/cm)	Ammonia (mg/L	Total Nitrogen (mg/L)	Total Phosphorus (mg/L)	Dissolved Oxygen (mg/L)	NO_x (mg/L)	Reactive Phosphorus (mg/L)	Comments
8/01/2020	8433/1	Tributary Confluence	24.3	7.5	644	0.013	**1.2**	**0.1**	4.8	0.01	<0.005	
8/01/2020	8433/2	Upstream	23.3	7.2	524	**0.081**	**1.3**	**0.2**	3.3	<0.005	**0.027**	
8/01/2020	8433/3	Downstream	22.6	7.5	993	**0.094**	**1.5**	**0.07**	3.7	**0.1**	0.013	
21/05/2020	9069/1	Tributary Confluence	15.8	7.2	576	**0.071**	**1.2**	**0.2**	3.9	0.03	**0.064**	
21/05/2020	9069/2	Upstream	15.7	7.3	582	**0.039**	**1.5**	**0.3**	6.1	0.04	**0.12**	
21/05/2020	9069/3	Downstream	16.2	7.1	595	**0.075**	**1.0**	**0.1**	5.6	**0.06**	**0.033**	
Average			17.3	7.4	1,491	0.107	2.4	0.31	6.9	0.036	0.106	**Note: Results in bold where in outside of ANZECC criteria**
Minimum Value			5.9	6.3	255	0.000	0.4	0.00	3.0	0.000	0.000	
Maximum Value			24.4	8.9	3,820	1.300	19.0	1.90	18.9	0.500	0.540	
95% Confidence Interval Minimum Value			15.3	7.2	-	-	-	-	-	-	-	
95% Confidence Interval Maximum Value			19.3	7.5	1,875	**0.188**	**3.8**	**0.47**	8.2	**0.070**	**0.159**	
ANZECC (Criteria for South-East Australia Lowland Rivers Physical and Chemical Stressors)			-	6.5-8.0	125-2,200	0.02	0.5	0.05	-	0.04	0.02	

Graph 2: Results for pH of Badgerys Creek

Graph 3: Results for Electrical Conductivity of Badgerys Creek



Graph 4: Results for Total Nitrogen of Badgerys Creek



Graph 5: Results for Total Phosphorus of Badgerys Creek

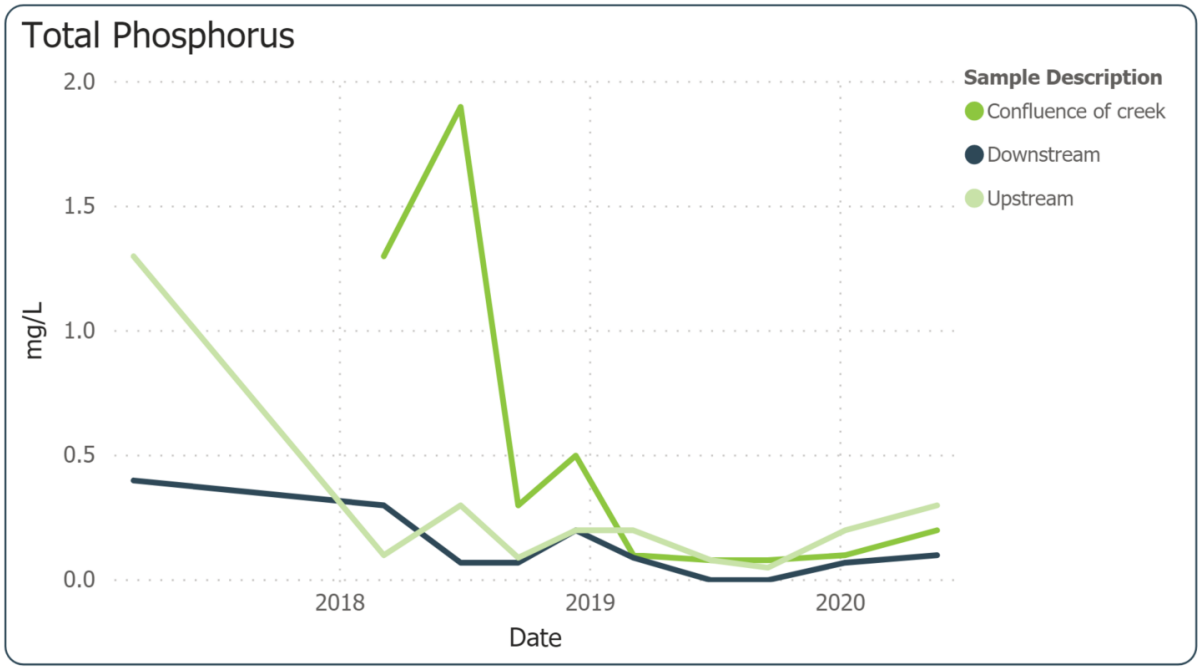


Table 15. *Pit 1 Baseline Water Quality*

Date	Sample ID	Sample Description	Temp. (ºC)	pH	Conductivity (µS/cm)	Comments
2/12/2015	2320/3	Pit 1	26.5	**8.7**	2,170	Clear, not discharging
1/12/2016	3648/2	Pit 1	22.9	**8.8**	2,030	-
6/03/2017	3888/3	Pit 1	24.5	**8.8**	2,080	No Visible Oil and Grease
Average			24.6	8.8	2,090	**Note: Results in bold where in exceedance of ANZECC criteria.**
Minimum Value			22.9	8.7	2,030	
Maximum Value			26.5	8.8	2,170	
ANZECC (Criteria for South-East Australia Lowland Rivers Physical and Chemical Stressors)			-	6.5-8.0	125-2,200	

Table 16. *Pit 2 Baseline Water Quality*

Date	Sample ID	Sample Description	Temp. (ºC)	pH	Conductivity (µS/cm)	Comments
2/12/2015	2320/4	Pit 2	26.6	**8.7**	**3,110**	Clear, not discharging
1/12/2016	3648/1	Pit 2	22.8	**8.8**	**2,890**	
6/03/2017	3888/4	Pit 2	25.5	**8.7**	**3,170**	No Visible Oil and Grease
Average			25.0	8.7	3,060	**Note: Results in bold where in exceedance of ANZECC criteria.**
Minimum Value			22.8	8.7	2,890	
Maximum Value			26.6	8.8	3,170	
ANZECC (Criteria for South-East Australia Lowland Rivers Physical and Chemical Stressors)			-	6.5-8.0	125-2,200	

Table 17. ***Pit 3 Baseline Water Quality***

Date	Sample ID	Sample Description	Temp. (ºC)	pH	Conductivity (µS/cm)	Comments
2/12/2015	2320/5	Pit 3	26.4	**9.2**	2,070	Clear, not discharging
6/03/2017	3888/5	Pit 3	24.0	**9.3**	1,910	No Visible Oil and Grease
Average			25.2	9.3	1,990	**Note: Results in bold where in exceedance of ANZECC criteria.**
Minimum Value			24.0	9.2	1,910	
Maximum Value			26.4	9.3	2,070	
ANZECC (Criteria for South-East Australia Lowland Rivers Physical and Chemical Stressors)			-	6.5-8.0	125-2,200	

As can be seen in *Table 14* above, the background water quality of Badgerys Creek has frequently been in exceedance of nearly all parameters as set out under the ANZECC- *Criteria for South-East Australia Lowland Rivers, Physical and Chemical Stressors*. This is consistent with the highly disturbed nature of the water course and the naturally saline geology in which it lies.

There has been a noticeable drop in the conductivity of Badgerys Creek in the last two monitoring quarters, with results below the ANZECC criteria. A review of BOM rainfall data for the Badgerys Creek Airport revealed that significant rainfall was received in the latter part of 2018 and aerial photography confirms that the creek has transformed from dry in early 2018 to a wet flowing system since late September 2018 to the present. This is likely to have washed accumulated salts from the creek bed downstream and resulted in a less saline environment.

Nutrients have also decreased in response to the higher rainfall and continued flows in the creek, however they still often exceed the ANZECC criteria.

Monitoring will continue in order to assess the changes in the water quality of the creek over different rainfall conditions in order to refine the baseline data and derive performance criteria and trigger values for the site.

Chlorophyll (A) has not been included in the testing regime due to the extensive presence of algae in Badgerys Creek.

4.3. Rehabilitated Area Design Objectives and Performance Criteria

Design objectives and performance criteria for reinstatement of drainage lines on any rehabilitated areas of site as well as control of any pollution from rehabilitated areas of the site are shown in *Table 18*. Design objectives are expected to be achieved progressively as rehabilitation phases are completed. Timing is dependent on the backfilling operations progress and extraction activities, however at the completion of the project, all objectives should be achieved.

Table 18. ***Design Objectives and Performance Criteria for Rehabilitated Areas***

Aspect	Objectives	Performance Criteria
Decommissioning	Sediment runoff to be contained prior to treatment (if required) and release.	Temporary Sediment Dams to be constructed, if required, will be designed to Best Practice according to the 'Blue Book' Criteria for a 5 day 90th percentile storm event. All drains and reinstated drainage lines will be designed for the 1 in 10-year design storm event and do not re-entrain sediment. All spillways will be designed for the 1 in 100-year design storm event and do not re-entrain sediment.
	Domain landform is safe, stable and non-polluting, fit for the purpose of the intended final land use	Landform drains towards final water bodies or temporary sedimentation dams installed during the landform establishment phase. All drains and reinstated drainage lines will be designed for the 1 in 10-year design storm event and do not re-entrain sediment. Slopes are generally no greater than 3m horizontal to 1m vertical or will blend into the surrounding natural slopes. Slope lengths shall not exceed 35m for a 3m Horizontal: 1m Vertical batter before a cross-drain is installed.
Growth Medium Development	Suitable planting medium is established.	Site preparation for topsoiling involves ripping along the contours to a depth of 10 to 20cm. Topsoil is applied to a depth of 5 to 10 cm.

Aspect	Objectives	Performance Criteria
Ecosystem Establishment	The rehabilitated area does not constitute an erosion hazard.	Groundcover including topsoil, vegetation or similar etc. will endeavour to have a C factor of 0.01 or less (equivalent of 70% groundcover by vegetation). The required C factor will be achieved temporarily (whilst awaiting establishment of vegetation) by mulch, spray grass or suitable soil binders. Water Quality meets the objective of Section 120 of the Protection of the Environment Operations Act 1997.
Ecosystem Sustainability	Clean water flows are restored to downslope areas.	Temporary Sediment Dams are removed, if required, and both overland flows and reinstated drainage lines convey clean water. Water Quality meets the objective of Section 120 of the Protection of the Environment Operations Act 1997. Groundcover is maintained at a C factor of 0.01 or less (equivalent of 70% groundcover by vegetation).

4.4. Site Performance Criteria

Baseline criteria for assessment of performance of the Site with regard to the on-site water management system as well as potential off-site impacts on water quality and stream health are shown in *Table 19*. The off-site performance criteria and trigger values for water quality and stream health reflect the degraded environmental values in Badgerys Creek (AECOM, 2010).

Table 19. ***Site Trigger Levels and Performance Criteria***

Aspect	Trigger Level	Performance Criteria
Creeks and Other Water Bodies		
Water Quality in Creeks	Trigger levels are under development and the values listed below are indicative and will be subject to further refinement as more data becomes available. It should be noted that the site at present does not discharge to the creeks and therefore all monitoring to date is for background data gathering purposes. pH: 6.5 – 8.0 (ANZECC). Turbidity <150 NTU* OR Total Suspended Solids (TSS) <50mg/L. Note: it is proposed to use turbidity measurements to monitor the quality of the water in lieu of TSS.	No exceedance of the trigger levels due to site activities.
Stream Health	Visual baseline to be established in close vicinity to the following points: • Discharge Point into Badgerys Creek; • 100 m upstream of the discharge point into Badgerys Creek. • 100 m downstream of the confluence point of Badgerys Creek tributary and Badgerys Creek Establish transect for assessment of changes to channel morphology, including geo-referenced photo point monitoring at each of the three above points Condition assessment of riparian vegetation to establish baseline photo point monitoring at each of the three above points	No significant visual variation from baseline identified in biannual spring and no significant observed variation from baseline vegetation condition identified in biannual spring and autumn monitoring

*The measurement of Turbidity (with a limit of 150 NTU), in place of Total Suspended Solids, is consistent with EPL limits on similar sites operated by PGH. It is expected that Badgerys Creek will apply the same principles to permit the measurement of turbidity on discharge in the EPL, which may include a statistical correlation which identifies the relationship between Turbidity and TSS.

4.5. Surface Water Monitoring Program

A monitoring program to assess performance and effectiveness of the surface water system, including surface water quality flows, sediment and erosion controls, water quality in Badgerys Creek stream health and a plan for responding to any exceedances of performance criteria is documented below.

South Creek has not been monitored to date as current overland flows and overflows from Sediment Dam 3 and Farm Dam 5 are considered clean water. Monitoring will commence as soon as practical both upstream and downstream in South Creek in order to establish baseline data.

4.5.1. Surface Water Management System Effectiveness

The site environmental officer or other delegated PGH representative will undertake regular inspections to assess the integrity of on-site sediment and erosion control systems. This will comprise assessment of permanent structures as well as those temporarily installed by contractors working in specific areas.

Maintenance actions applicable to the Badgerys Creek brick works site include the following:

- Inspection of permanent structures, such as water storage pits and sedimentation basins, are undertaken after rainfall events exceeding 25 mm in a 24-hour period.
- Inspection of temporary structures around construction areas, overburden stripping areas and unconsolidated stockpiles will be undertaken prior to the commencement of works and thereafter following 25 mm rainfall events and on a weekly basis.
- Inspections will include visual observations to check for erosion of surfaces on site as well as sedimentation within the water management network. An erosion and sediment control maintenance check list is provided in *Appendix B.* The checklist will be updated as required to account for changes to the site management.

Where structures or systems are found not to be functioning effectively this will be restored to ensure that they align with requirements outlined in this Plan as well as legislative and best practice requirements documented in *Section 2.0*.

4.5.2. Surface Water Flows, Quality and Stream Health

A monitoring program, presented in *Table 20,* has been developed to meet two objectives as documented in the Project conditions of approval:

- Report on impacts and environmental performance of the project.
- Assess the effectiveness of surface water management actions in meeting their objectives as documented above.

In addition, the surface water will be assessed for similar parameters to the groundwater, as discussed in the Groundwater Management Plan, in order to establish the extent of any potential influences between the ground water and surface water. Sampling and analysis

methods will comply with the NSW EPA Approved Methods for the Sampling and Analysis of Water Pollutants in NSW dated 2004, or as may be updated from time to time.

This monitoring program will be implemented from the approval of this Plan and sustained for the next five years and will be subject to review thereafter.

Table 20. ***Proposed Surface Water Monitoring Program***

Action Description	Location	Performance Criteria	Target	Frequency
Monitor stream health (including water quality) at three locations: a Discharge Point b Upstream from of Discharge Point c Downstream from Discharge Point	Discharge Point into-Badgerys Creek; Upstream of discharge; Downstream of discharge; South Creek Upstream; South Creek Downstream Note: there is currently no discharge to South Creek.	See Section 4.2.4 & 4.4. pH: 6.5 – 8.0 (ANZECC) Turbidity <150 NTU	No deterioration in water quality within Badgerys Creek or South Creek due to site activities.	Quarterly and following rainfall events exceeding 25mm in a 24-hour period.
Monitor surface waters prior to discharge.	Sediment Basins	pH: 6.5 – 8.0 (ANZECC) Turbidity <150 NTU	No deterioration in water quality within Badgerys Creek due to site activities.	As required on discharge.
Monitor geomorphology and riparian vegetation condition in Badgerys Creek	Badgerys Creek	N/A Baseline has not been established to date. To be established as soon as practical.	No deterioration from baseline for riparian vegetation condition and morphology	Quarterly
Monitor on-site rainfall, all water used on site, brought to site, discharged from site, transfers from site and water storage pit levels. This information will be used to update site water balance where deviations occur	Site wide	N/A	N/A	Ongoing

All monitoring, testing and assessment will be undertaken in accordance with:

- Australian Guidelines for Water Quality Monitoring and Reporting (ANZECC, 2000)
- Australian Standard AS 5667.1998 Water Quality Sampling.

Monitoring documentation will include:

- Sample dates
- Field sampling records
- Instrument calibration records
- Sample of chain of custody records
- Analytical requests.

All laboratory analysis will be undertaken at a NATA accredited laboratory under chain of custody.

5.0 Site Water Balance

5.1. Overview of Inflows and Outflows

An overview of annual inflows and outflows to the site is shown in *Table 21 and is based on data supplied in the AECOM 2010 report* [Ref. 1].

Table 21. ***Existing Site Water Inflows and Outflows Per Annum***

Inflows	ML per annum	Outflows	ML per annum
Initial system storage	1,140	Evaporation from water body surfaces	187
Direct rainfall received over whole of the site	1,238	Seepage Losses (assumed to be negligible)	Nil
Groundwater inflows (negligible)	Nil	Dust suppression	Nil
Potable water (for amenities)	3	Spills (from Pits 1, 2 and 3)	Nil
		Potable water though the sewer system (for amenities)	Nil
		Site runoff (surface water not retained in dams including undisturbed areas)	73
		Discharge	Nil
Total	2,381	Total	271
Net Water Remaining		**2,110 ML**	

Table 21 provides an approximation of the annual water balance based on the following assumptions.

- The initial system storage has been taken from the Crossmuller report [Ref. 5] ;
- The historical annual rainfall of 884mm [Ref. 1] has been applied to the whole site;
- Potable water usage has been reduced from that estimated in the AECOM 2010 report due to the continued closure of the brickworks and presence of only maintenance staff on the site;
- Evaporation has been averaged using AECOM 2010 data and taken to be 3mm per day over the current surface areas of the water bodies;
- Dust suppression usage has been estimated as 30KL/day for 5 days a week per annum of potable water when the site is operational;
- Site runoff includes surface water runoff into Badgerys and South Creek over the undisturbed areas that is considered clean water;

- Site runoff also includes clean water overflow from the Sediment Dam 1 and 2 system catchment and the Dam 3 system catchment which includes the concrete hardstand areas and roof area of the non-operational brickworks that do not contribute to the sediment load. These dams have been assumed to be at full capacity for the calculation and all surface water received overflows offsite; and
- Rainfall captured within Pits 1, 2 and 3 remains on site and there are no discharges at present off-site from these dams.

It is clear from Table 21 that there is currently not a deficit of water available to the site.

As a result of the Enforceable Undertaking with NRAR, Pits 1, 2 & 3 will be isolated from receiving surface water and dewatered. Dewatering is estimated to be at a rate of 100,000L/hr 24 hours a day, seven days a week to Badgerys Creek or alternatively to the WSA at up to 10ML per day. The sediment basins to be constructed to capture the site surface water will discharge water to Badgerys Creek under EPL conditions and will not retain water on the site. The following water balance investigates the volumes of water expected to be held on site during the proposed backfilling and extraction operations.

The inflows and outflows will be reviewed once extraction operations commence.

5.2. Ten Year Water Balance

A water balance has been undertaken for the development as proposed in Mod 3 and 4 (the Preferred Project). In this scenario Pits 2 and 3 are to be emptied into Pit 1 to allow for extraction in Pit 3 and backfilling of Pit 2. Pit 1 will then be transferred to the WSA or discharged to Badgerys Creek. Sediment Basins A and B will be constructed and will capture water over the disturbed areas, isolated from the Pits, with final discharge to Badgerys Creek. Water captured over the Pits, once emptied will be transferred to the Basin system for discharge whilst backfilling operations are undertaken.

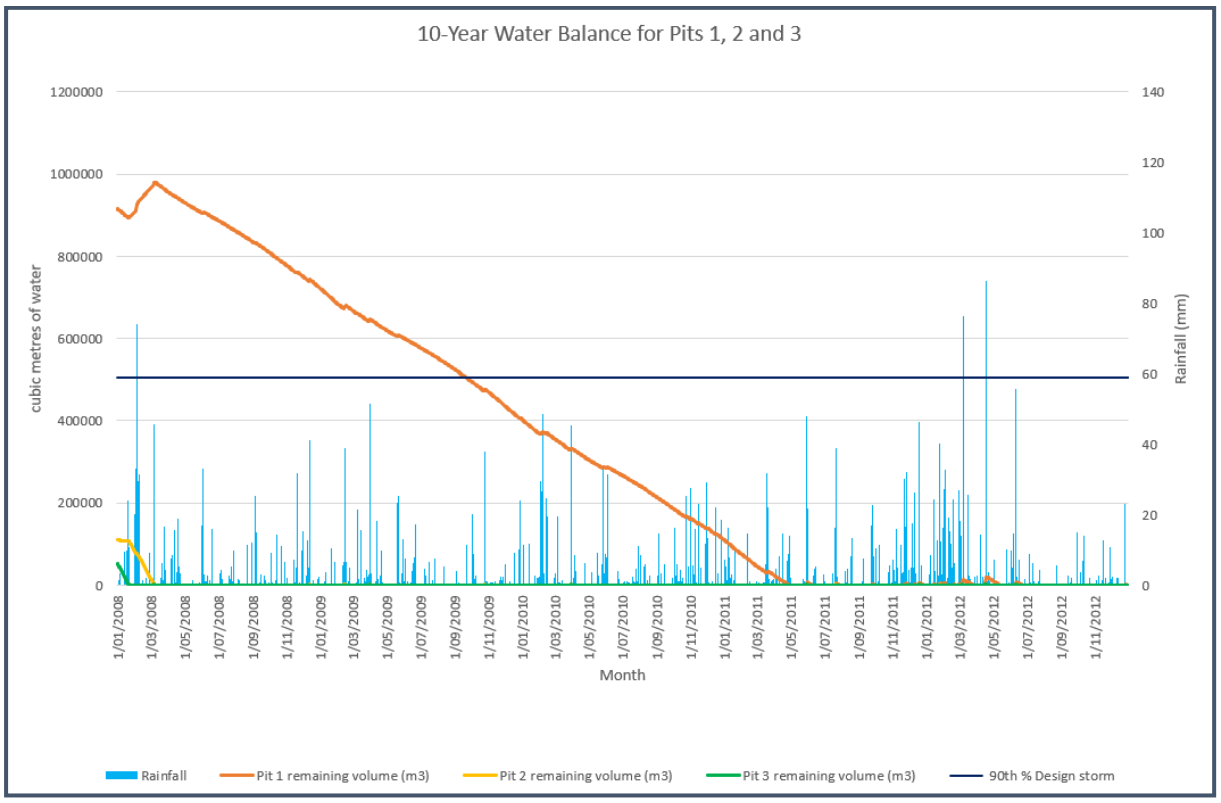
The water balance was modelled over a 10-year critical period from 2008 to 2017 that includes average and both wet and dry conditions. Assumptions made for the water balance model are listed below.

- The initial system storage has been taken from the Crossmuller report [Ref. 5] ;
- The average rainfall over the critical 10-year period is 909mm and compares with the historical annual rainfall of 884mm [Ref. 1];
- Daily evaporation has been taken from the Prospect Reservoir (BOM station 067019). The pits are assumed to have vertical sides for the purposes of calculating evaporation rates;
- Dust suppression usage has not been included as it will utilise potable water;
- Surface water runoff into Badgerys and South Creek over the undisturbed areas that is considered clean water are not included;
- Pit 1 will be dewatered at an average rate of 29,000L/hr (noting that the maximum pump rate of 10ML/day may not apply each day in practice), 24hrs/day, to the WSA

over a 3yr period to as the water is required for their operation. Alternatively Pit 1 will be dewatered to Badgerys Creek @ 100,000lt/hr, 24hrs/day to Badgerys Creek;

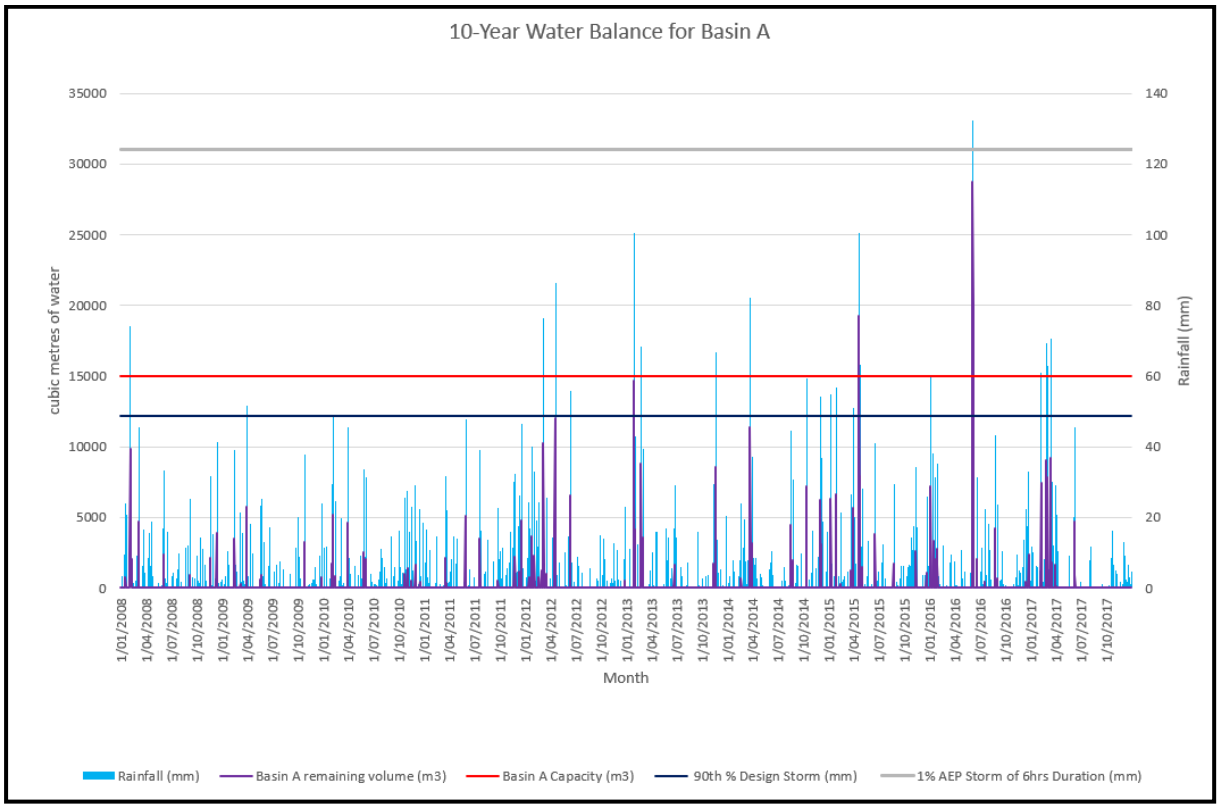
- Pit 2 and 3 will be dewatered at a rate of 100,000L/hour, 24 hours per day, to Pit 1, concurrently with dewatering Pit 1. Pit 3 will be dewatered first, then Pit 2;
- Water from Sediment Basin A will be transferred to Sediment Basin B as required at a rate of 6000L/min, 24 hours per day;
- Water from Sediment Basin B will be transferred to Badgerys Creek as required at a rate of 17,000m^3 per day i.e. the dam is emptied over a 24-hour period;
- Once Pit 3 is dewatered, subsequent rainfall captured in the Pit will be transferred to Sediment Basin A and transferred as above;
- Once Pits 1 and 2 are dewatered, subsequent rainfall captured in the pits will be transferred to Sediment Basin B for treatment and discharge; and
- The catchments for each pit/basin have been taken from the *High Definition Design Pty* Ltd design drawings **Ref. 7** (see *Figure Eight*) and are as follows;
    - Pit 1- 24.1Ha;
    - Pit 2- 7.9Ha;
    - Pit 3- 5.9Ha;
    - Sediment Basin A- 26.4Ha;
    - Sediment Basin C- 0.9 Ha (dam surface area only).

Graph 6: Dewatering Water Balance Modelling for Pit 1,Pit 2 and Pit 3

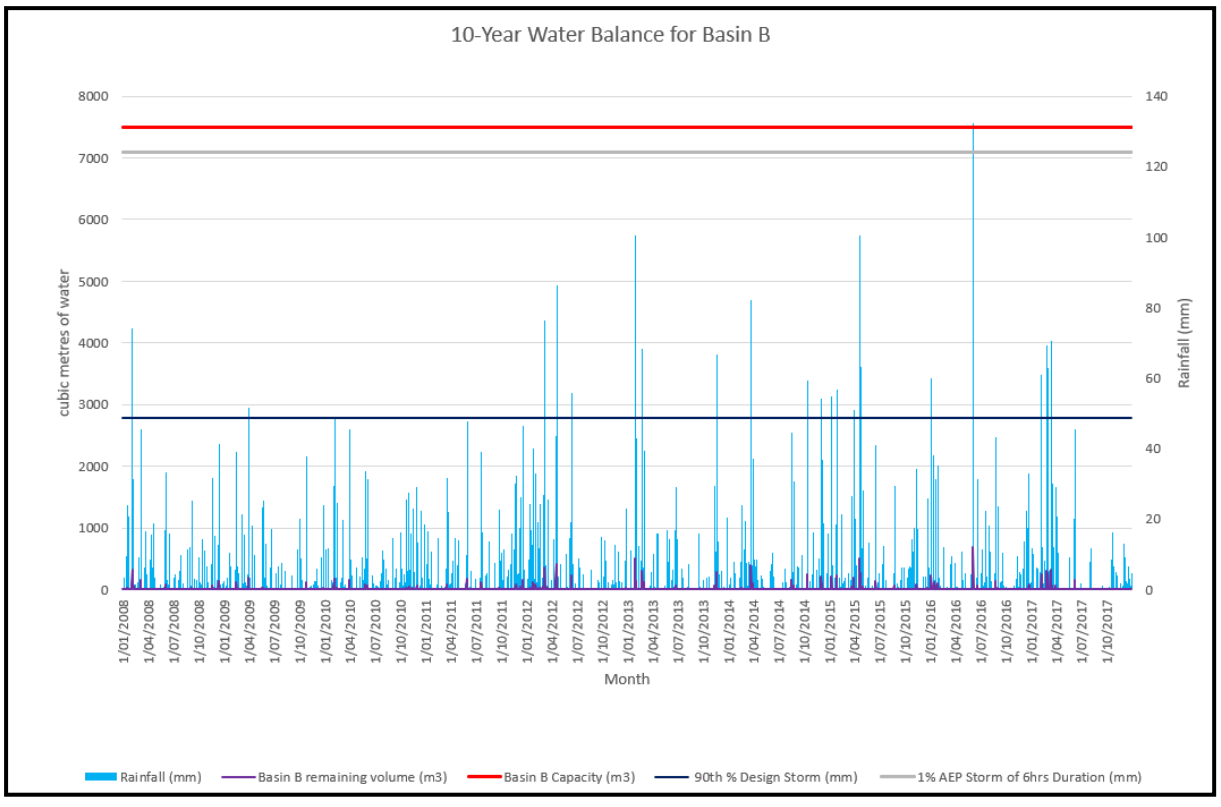


As can be seen from Graph 6: Dewatering Water Balance Modelling for Pit 1,Pit 2 and Pit 3, dewatering of Pits 2 and 3 will take several months each and Pit 1 will take approximately three years based on rainfall for the critical period between 2008 and 2017.

Graph 7: Sediment Basin A 10-year Water Balance



Graph 8: Sediment Basin B 10-year Water Balance



As can be seen from the graphs above, Sediment Basins A and B are not expected to overtop in rainfall events below the 5-day, 90th percentile design storm. Where the modelling suggested they overtop, rainfall over a 2-3-day period was in exceedance of 230mm, well above the 124mm of a 1%AEP. The frequency of overtopping is well below the Blue Book acceptable criteria of 2-4 uncontrolled overflows per year.

5.3. Water Use On-Site

Water usage for the Badgerys Creek quarry was reported to be approximately 24.5 ML pa projected to increase by up to 30ML pa over the next 5 years (AECOM, 2010). The majority of this increase in usage was associated with demand from the brick making facility. At present the usage is very low as the brickworks remains closed and extraction has not commenced.

Potable water is used in the brick making process. It should be noted that at present the brickmaking facility is not operational and has therefore not been accounted for in the existing site water balance in *Table 21*. Potable water is used for drinking water, toilet flushing and other amenities. As the brick facility is not operational the potable water used on site is minimal with only care and maintenance staff utilising the facilities.

Dust suppression needs will be met by potable water in the initial stages of the development.

A summary of proposed water usage is presented in *Table 22*.

Table 22. *Proposed Water usage on Site*

Usage Activity	Source	Approximate water usage (KL/day)
Dust Suppression	Potable Water	30
Brick making process	Potable Water	22
Offices and amenities	Potable water	12

5.4. Water Sources and Security of Supply

The existing site contains approximately 57 hectares of pervious land with the remainder of the site impervious (AECOM, 2010). Water supply storage facilities, including sedimentation dams as well as surface water flows are presented in *Figure Three* based on current operations for the site. On-site water storage and supply structures applicable to the 5-year horizon for this Plan are presented in *Table 23.*

Table 23. ***Proposed Water storage and supply structures and on-site water flows***

Water Storage and Supply Structures	Water Flows
Sediment Dam 3	Receives roof drainage from the brick making facility flows via the gutter, downpipe, external perimeter open drain, pipe, thence a grass swale to Sediment Dam 3.
Sediment Dam 1 and 2	Sediment Dam 1 overflows into Sediment Dam 2. The catchment of Sediment Dam 1 includes the area around the brick making facility, gate house, pallet storage area and a small overland flow component.

Potable water will be utilised to supply water needed for the brickworks, offices and dust suppression activities. A Water Access Licence (WAL) may be sought to supply dust suppression water from the Sediment Dams as the development proceeds.

5.5. Measures for Minimisation of Potable Water Use On-Site

As the site does not currently hold a Water Access Licence (WAL) for the re-use of surface water on the site and in view of the Enforceable Undertaking requirement to dewater the pits, the use of potable water is unavoidable. Outside of the EU works, all dirty water will be treated, if required, and returned to the downstream environment. It is not intended to be reused on the site. This may be reviewed as site requirements change.

5.6. Reporting Procedures

Any changes to the current site water balance will be presented in the Annual Rehabilitation Report (ARR). Provisions will be made to ensure that the water balance is updated on an annual basis or when appropriate. Potential options for minimisation of potable water use on site will also be reported in the first ARR.

Table 24. *Trigger Action Response Plan*

Rehabilitation Threat	Potential Adverse Outcome	Trigger level	Actions to be implemented	Evidence / Reference
Overland flows from clean water catchments on the site are not consistent with the baseline ecological, hydrological and geomorphic conditions of the surrounding environment.	Significant variation from baseline riparian vegetation condition.	Significant observed variation from baseline vegetation condition identified in biannual spring and autumn monitoring (to be undertaken). *Note: Trigger levels will be developed once baseline data has been obtained.*	• Assess the variation and determine the root cause of the variation • Develop and implement a response management plan in consultation with suitably qualified experts, DPIE and OEH if the root cause is determined to be due to site activities.	
	Significant variation in baseline channel morphology.	Significant visual variation from baseline identified in biannual spring (to be undertaken). *Note: Trigger levels will be developed once baseline data has been obtained.*	• Assess the variation and determine the root cause of the variation • Develop and implement a response management plan in consultation with suitably qualified experts and DPIE if the root cause is determined to be due to site activities.	

Rehabilitation Threat	Potential Adverse Outcome	Trigger level	Actions to be implemented	Evidence / Reference
Sediment dams overtop into the Badgerys or South Creeks.	The site is a source of water pollution adversely impacting aquatic ecology.	Sedimentation Dams observed to be unable to contain the design storm event i.e. 90th percentile 5-day storm event. *Note: dams will have indicators installed to record the trigger capacities.*	• Re-use a much water as possible on site i.e. dust suppression, water revegetation etc once appropriate water licencing is in place. • Flocculate the Sediment Dam at risk of overtopping with approved methods to reduce sediment load in water that may potentially spill off-site. • Variation of the EPL to include off-site discharge where appropriate. • Liaise with EPA and DPIE to seek advice on potential actions to be taken.	Reports to EPA and DPIE. Annual Review documents. Approved MOP. This Water Management Plan.
	Significant variation from baseline riparian vegetation condition.	Trigger Levels are yet to be determined as no baseline data available yet.	Actions to be implemented are yet to be determined.	To be determined.
	Significant variation in baseline channel morphology.	Trigger Levels are yet to be determined as no baseline data available yet.	Actions to be implemented are yet to be determined.	To be determined.

Rehabilitation Threat	Potential Adverse Outcome	Trigger level	Actions to be implemented	Evidence / Reference
The landform, whether through extraction or rehabilitation activities, is not properly protected from erosion.	The landform is a source of pollution due to sediment entrainment adversely impacting aquatic ecology.	Surface water monitoring records indicate that water quality levels are outside the performance criteria. Visual inspection indicates that the final landform is the source of unacceptable levels of sedimentation or is actively eroding.	• Site manager to identify site of erosion and remediate through additional\ earthworks, soil works including addition of ameliorants, supplementary revegetation or another stabilisation method. • If the above is unsuccessful, a suitably qualified professional in sediment and erosion control will be engaged to prepare and assessment report and recommendation	Managing Urban Stormwater 'Blue Book' 2004 CPESC Report.

6.0 Groundwater Management Plan

6.1. Pit Water Management Measures

Water collected within the current excavations will be managed in accordance with the EU, the Dewatering Infrastructure Plan and the Dewatering Management Plan. Once emptied, any surface water or groundwater seepage collected within the pits will be managed in accordance with the Surface Water Management Plan (SWMP). Pits 1 and 2 will be backfilled and potential groundwater seepage will be eliminated.

6.2. Depth of Extraction

A registered surveyor will mark out the boundaries of the approved extraction areas. These boundaries will be marked on site using large pegs with high visibility markings and a written explanation as to what they represent (eg NE cnr Pit 3) prior to the commencement of quarrying in each extraction area.

Within these extraction areas, PGH will not extract any extractive materials or carry out any work in the extraction area below 35 m below the pre-existing natural surface of the ground, other than construction of approved bores or in-pit sumps. The depth of extraction will be confirmed annually via survey.

6.3. Spill Management Measures

Measures will be implemented to provide for the appropriate storage of fuels and hazardous chemicals, implementation of appropriate work procedures as well as regular inspections and maintenance of equipment and plant to minimise potential for contamination of groundwater associated with spills.

Fuels and hazardous chemicals will be contained and bunded in accordance with relevant Australian Standards. Maintenance of equipment and plant will be undertaken only on sealed, bunded hard stands, or off-site. Spill kits will be located appropriately around the site and within select mobile equipment, and the use of these included in site inductions.

The site Maintenance Manager (within the brick manufacturing area) and the Quarry Manager (within the active excavations) will be responsible for the implementation, use and up-keep of these management features, and for undertaking inspections at least annually, and before and after adverse storm events.

7.0 Groundwater Monitoring Program

A monitoring program to determine baseline characteristics of the alluvium and associated surface water source near the proposed extraction areas has been undertaken. The purpose of this monitoring program was to inform the Alluvial Aquifer Assessment (see *Appendix I*) which was completed in January 2019, and determine impact assessment criteria against which the performance of the project can be assessed.

7.1. Background Monitoring

A total of 8 standpipe piezometers have been installed to augment monitoring installations in place from previous programs (5 boreholes were located in March 2018), as shown on *Figure Three*. Drilling was undertaken by Highland Drilling using a track mounted multi-purpose rig set up with 110mm auger flighted drill rods and air core rods utilising a 110mm air hammer with an auxiliary compressor. Monitoring installations are 50mm Class 18 tubular PVC with screened intervals.

Paired standpipes were installed at multiple locations which aims to investigate separation of groundwater or the existence of perched water tables between the shallow regolith and the base levels of the proposed excavations (near to the base of the Bringelly Shale). The program also aims at investigating the presence of alluvium that may be associated with either South Creek or Badgerys Creek. (Fulton, Jan 2019)

Table 25. ***Installed Groundwater Monitoring Bores***

Borehole Description	Easting	Northing	Depth Installed (m)	Screen Interval (m)	Surface Elevation (mAHD)
MW1	292234	6246988	31.55		63.99
MW2 (NE dam)	291981	6247251	27.46		64
MW3A	292325	6247237	9.3		64
MW3B (Concrete Pad)	292320	6247213	8.36		64
BW1A	291741	6247174	8	5 – 8	56.06
MW4 (NW corner Dam)	291752	6247168	24.28		56.43
BW2A	291911	6247442	8	5 – 8	56.29
BW2B	291914	6247440	33	27 – 33	56.40
BW3	292585	6247552	33	27 – 33	64.10
BW4A	293602	6247294	6	3 – 6	49.04
BW4B	293602	6247295	33	27 – 33	49.06
BW5A	293098	6246559	7	4 – 7	45.56
BW5B	293098	6246561	33	27 – 33	46.51

MW Bores – No record of bore construction. Depth installed measured onsite.

Groundwater level loggers have been installed in five monitoring bores to allow baseline trends to be collected. A baseline water quality sampling and testing program has

commenced. This background data will be presented annually to the relevant parties in accordance with *Section 7.0*.

7.2. Groundwater Inflows to Quarrying Operation

The EIS determined that the maximum depth of extraction of 35 metres is into very low permeability rock and that no significant groundwater would be encountered, as has been previous experience at the site. Groundwater in the top 35 metres is considered a fractured bedrock aquifer (associated with fractures rather than within the rock itself). The Hawkesbury Sandstone Aquifer lies more than 100 metres below the surface and is not threatened by the development.

The project has a current groundwater licence allocation of 25 ML per annum (WAL24346). Groundwater inflows into Pit 1 through the Wianamatta Shales from the Sydney Basin Central Groundwater Source have been predicted to be 21 ML per annum in the Groundwater Assessment (Fulton, Jan 2019), which is less that the WAL allocation. However, Pit 1 will be backfilled in accordance with the Mod 3 & 4 consent and will not contribute significantly, if at all, to groundwater inflows. Pit 3 is the only consented extraction area and is not expected to encounter significant groundwater at the consented depth of extraction of 35 metres below the pre-existing natural surface of the ground. The Pit Inflow modelling in the Ground Water Assessment (Fulton, Jan 2019) predicted that with the filling of Pit 1, the contribution of Pit 3 and 4 (approximately the amended Pit 3 area in Mod 3 & 4 consent) inflows would be less than 25 ML per annum.

Notwithstanding the above, any visible flows observed during excavation activities will be measured by capturing a measured volume over a known time period; for example, the time taken for a 25L bucket to be filled. If the seepage is too small to be collected, it shall be recorded using photography and GPS location. The dates and period of time for which the flow is observed will also be recorded. If the flow rate changes during the time period observed, the rate will be measured again.

Pumping from any excavation will be recorded in a logbook. Records will include date, time of commencement and cessation of pump, flow rate and/or water level at a reference point in the water source.

This data coupled with rainfall and evaporation from the preceding 12 months will be used to update the Site Water Balance (as described in the Soil and Water Management Plan). Any differences between the predicted model and the actual results would be used to estimate the groundwater inflows.

This will be reported as outlined in *Section 10.0.*

7.3. Groundwater Levels

Quarterly groundwater quality monitoring of the bores will be undertaken for the analytes listed in *Section 7.4.* Groundwater levels will continue to be continuously logged in the five bores where automatic loggers have been installed. Levels in other bores will be measured at least quarterly.

7.4. Groundwater Quality

7.4.1. Groundwater Assessment (Fulton 2019)

Groundwater quality testing and criteria has been informed by the Groundwater Assessment Ref. 7. It includes quarterly testing of groundwater monitoring bores, in-pit collected waters, and surface creek waters so that collected sources can be estimated. Parameters include:

- pH, EC and total dissolved solids (TDS);
- Major cations and anions;
- Dissolved metals (Aluminium, Arsenic, Chromium, Copper, Lead, Manganese, Molybdenum, Nickel, Selenium, Silver, Zinc, Boron, Iron); and
- Petroleum hydrocarbons

Analysis of the groundwater from the Groundwater Assessment is reproduced below.

Table 26. ***Groundwater Quality Summary from the 2019 Groundwater Assessment***

Table 3-4: Analytical Groundwater Chemistry Results

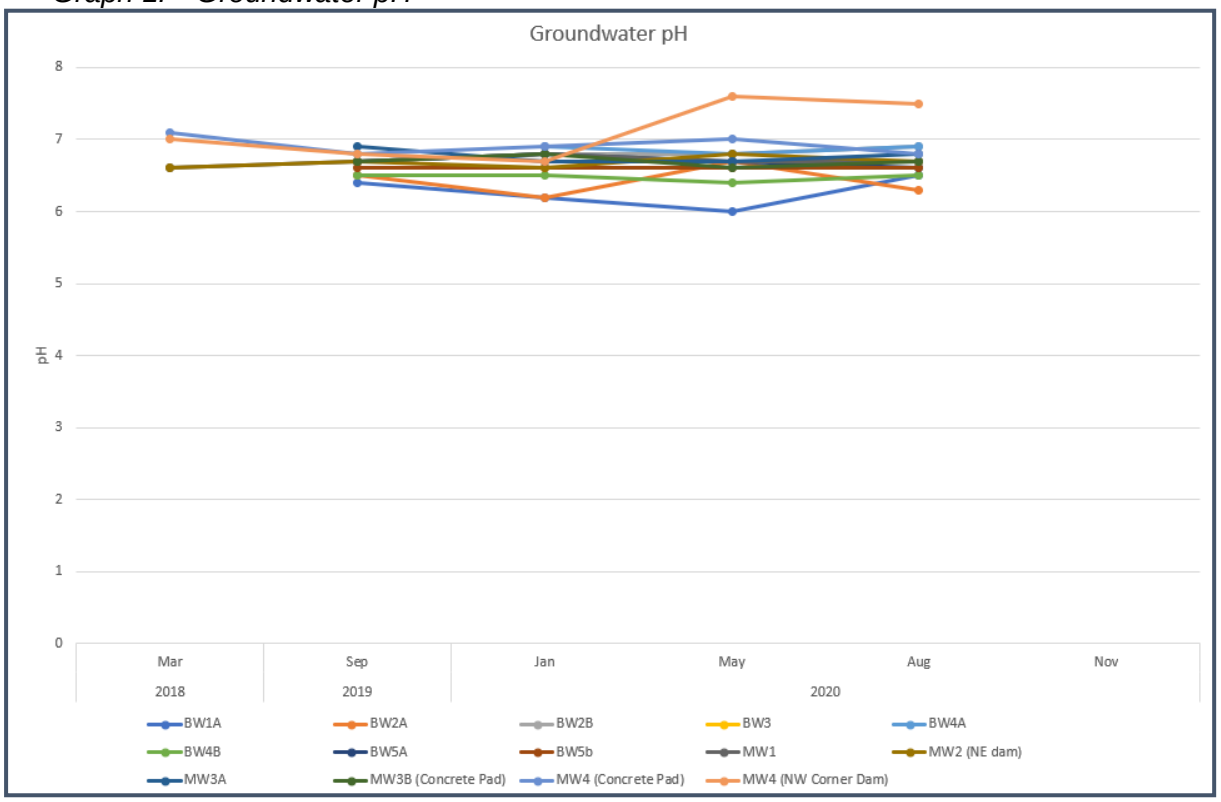
	BC1	MW4	BC2a	BC2b	BC3	BC4a	BC4b	BC5b	MW1
pH	6.97	7.3	6.92	7.12	7.1	7.68	7.05	7.14	7.12
Electrical Conductivity µS/cm	28800	24900	31600	21700	23100	20000	20700	21100	10200
Total Dissolved Solids	17200	18200	24700	13300	13700	13800	13000	14200	5130
Hydroxide ($CaCO_3$)	<1	<1	<1	<1	<1	<1	<1	<1	<1
Carbonate ($CaCO_3$)	<1	<1	<1	<1	<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	256	675	224	815	637	526	799	646	469
Total $CaCO_3$	256	675	224	815	637	526	799	646	469
Sulfate as $SO4^-$	1320	1050	816	341	53	210	<1	<1	398
Chloride	10400	8600	11500	7490	8290	6940	7290	7540	3120
Calcium	112	254	103	429	486	232	483	671	110
Magnesium	1170	912	1340	388	411	453	311	328	291
Sodium	5070	4300	5570	4020	4110	3550	3770	3670	1600
Potassium	10	15	3	55	71	11	65	71	23
Aluminum	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Arsenic	<0.001	0.001	<0.001	0.044	0.005	<0.001	0.009	0.003	<0.001
Chromium	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	0.008	0.002	0.082	<0.001	<0.001	0.001	<0.001	0.364	0.017
Lead	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Manganese	4.02	0.436	0.662	0.742	0.541	1.92	0.2	0.252	0.265
Molybdenum	0.002	<0.001	<0.001	0.001	0.002	0.001	<0.001	0.002	0.004
Nickel	0.106	0.004	0.024	0.003	0.002	0.061	0.003	0.082	0.042
Selenium	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Silver	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Zinc	0.141	0.015	0.027	<0.005	<0.005	0.207	0.03	0.081	0.015
Boron	<0.05	0.06	<0.05	0.19	0.15	0.14	0.07	0.06	0.08
Iron	<0.05	<0.05	<0.05	0.08	0.66	<0.05	0.78	<0.05	<0.05

The Groundwater Assessment found that all the groundwaters tested were below applicable criteria with the exception of Iron and Manganese (highlighted in red).

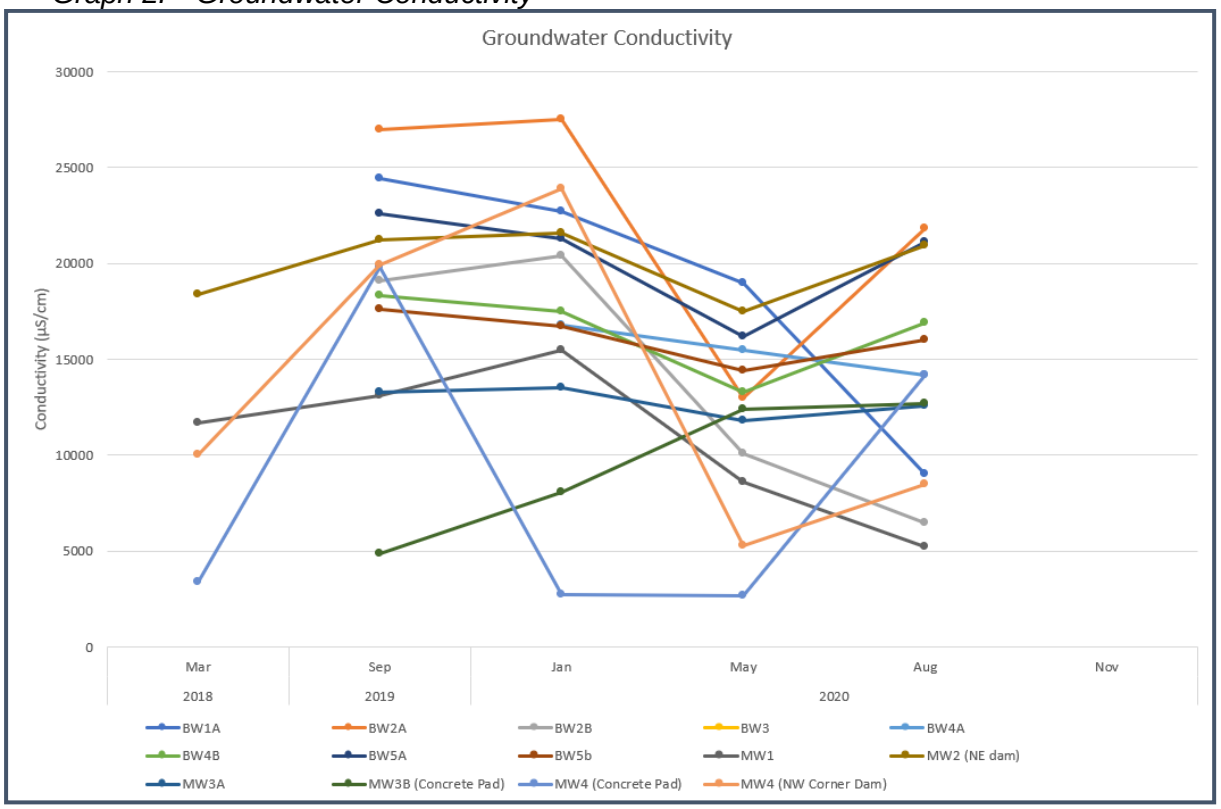
7.4.2. Quarterly Monitoring

Further monitoring has been undertaken quarterly and the results are graphed below.

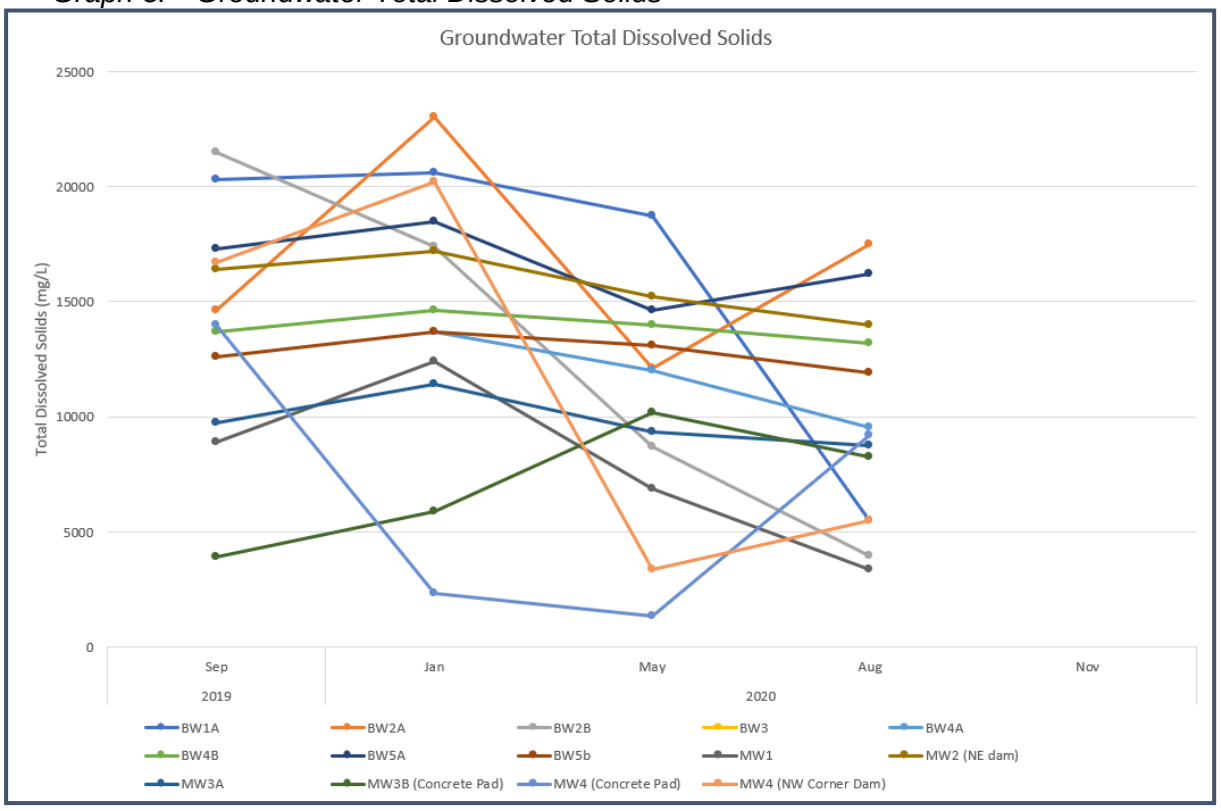
Graph 1. Groundwater pH



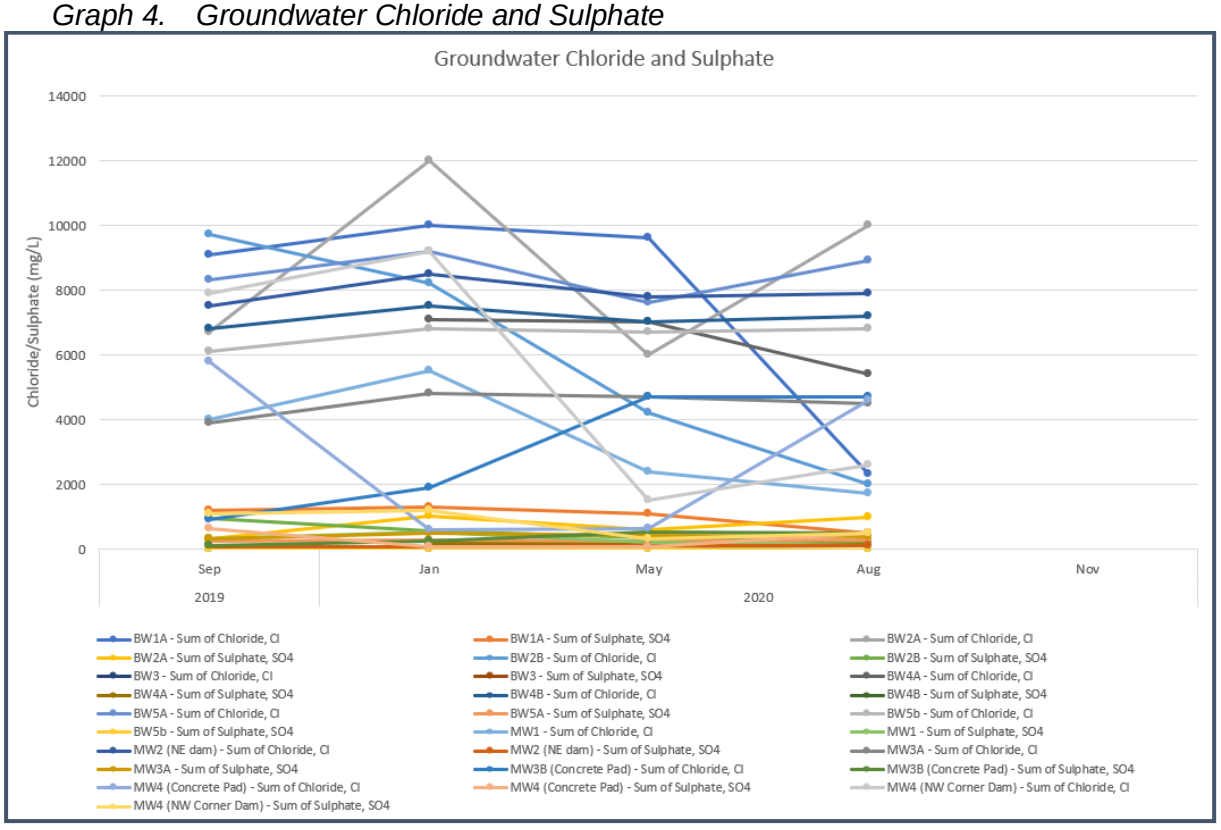
Graph 2. Groundwater Conductivity



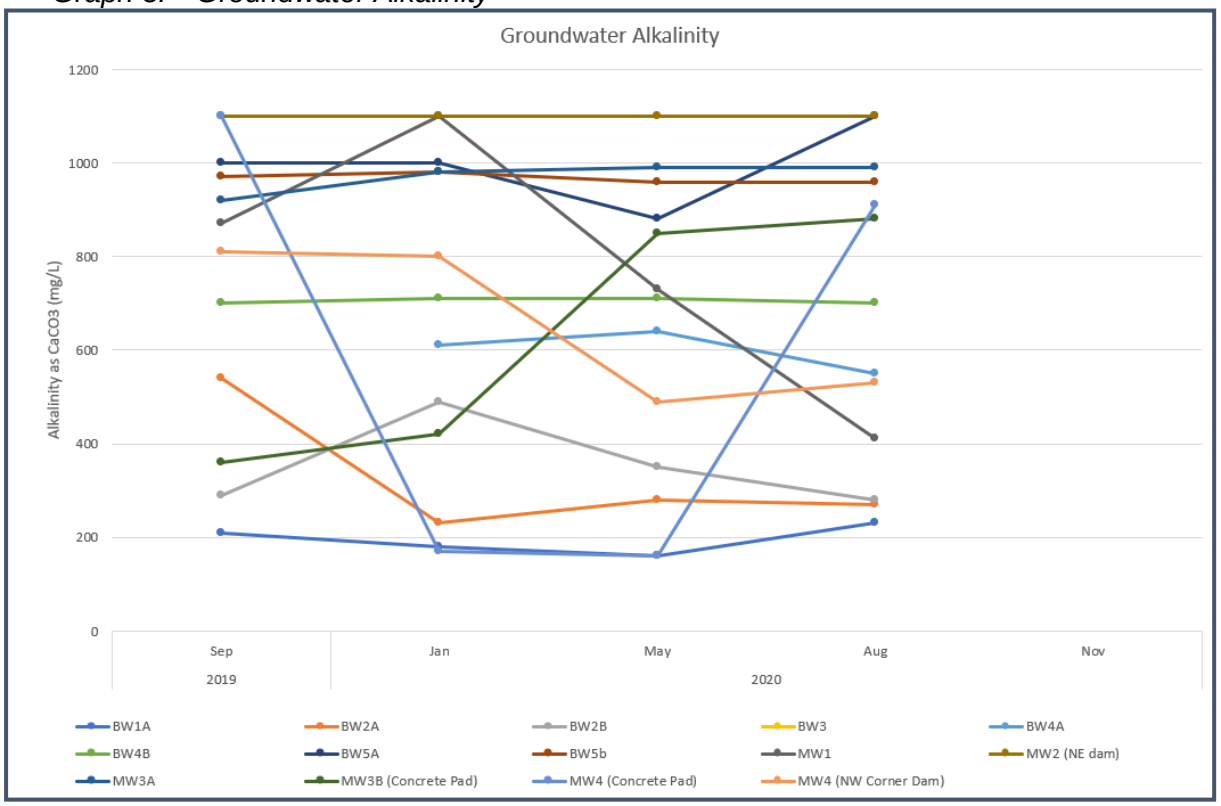
Graph 3. Groundwater Total Dissolved Solids



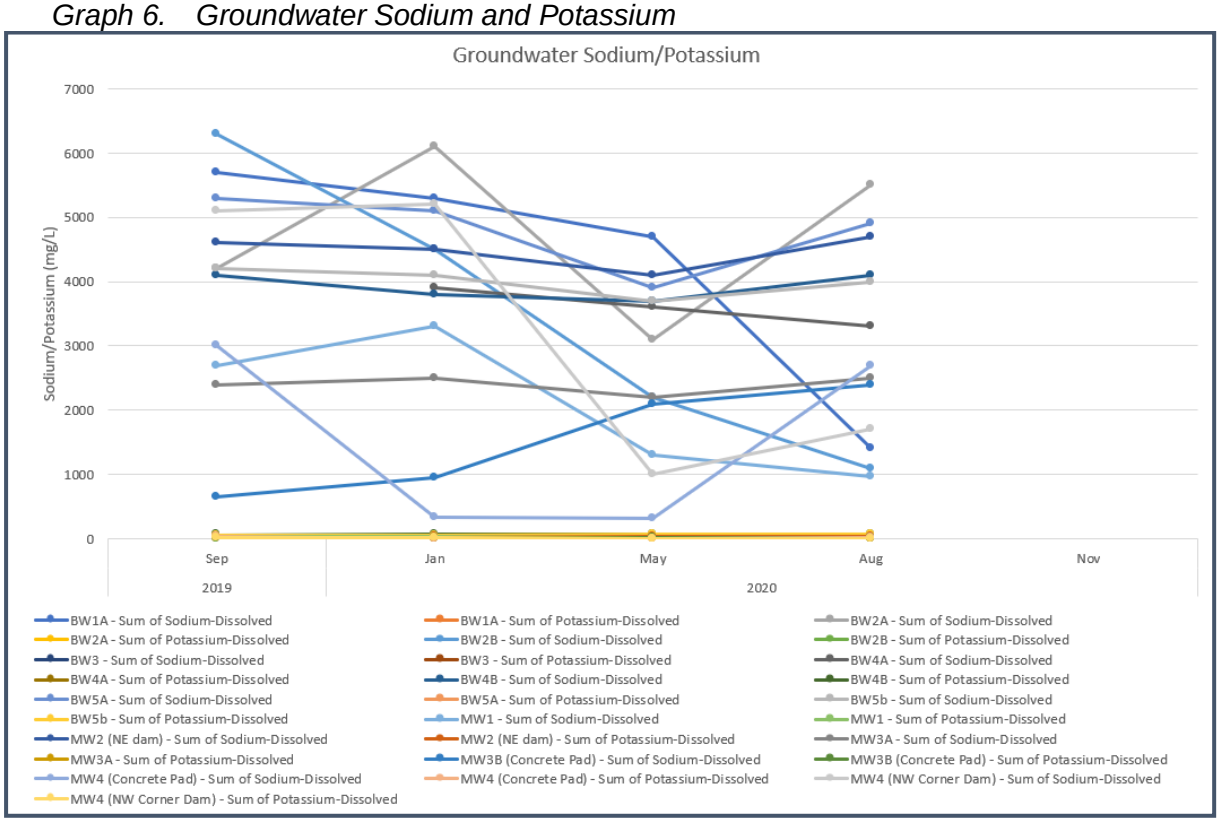
Graph 4. Groundwater Chloride and Sulphate



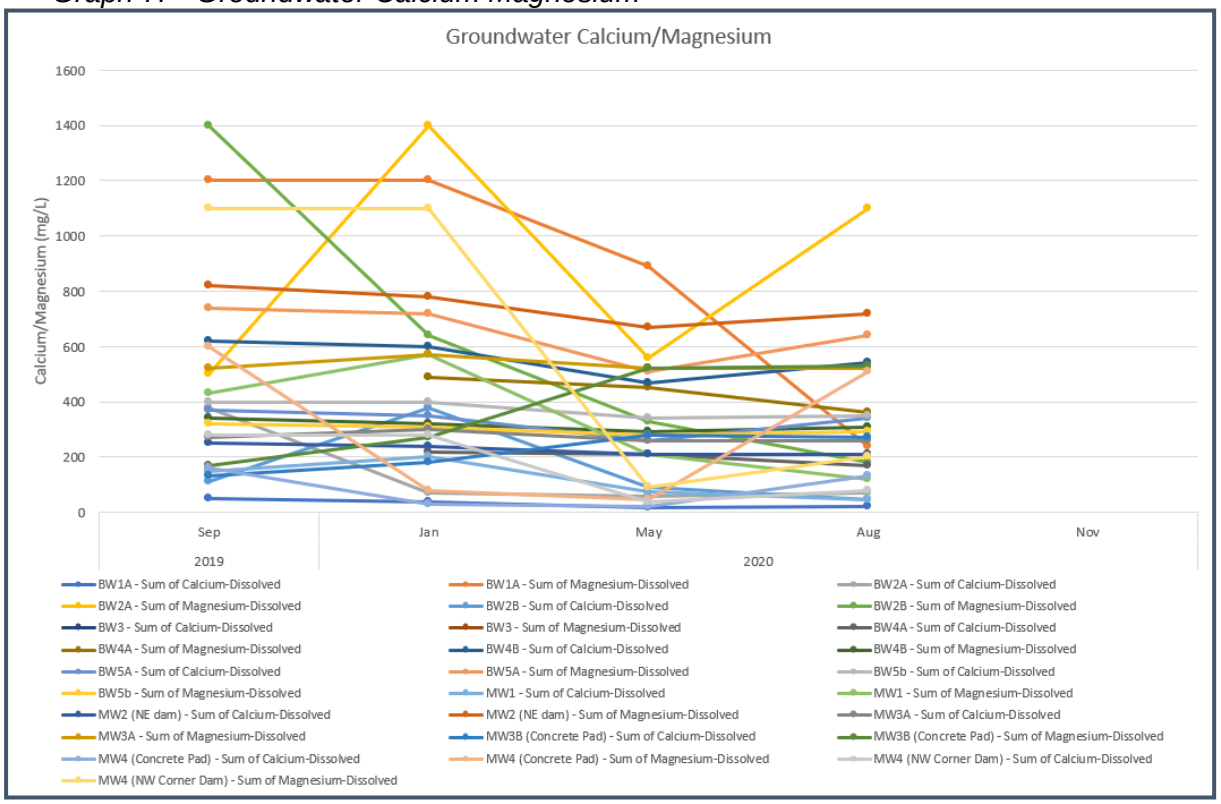
Graph 5. Groundwater Alkalinity



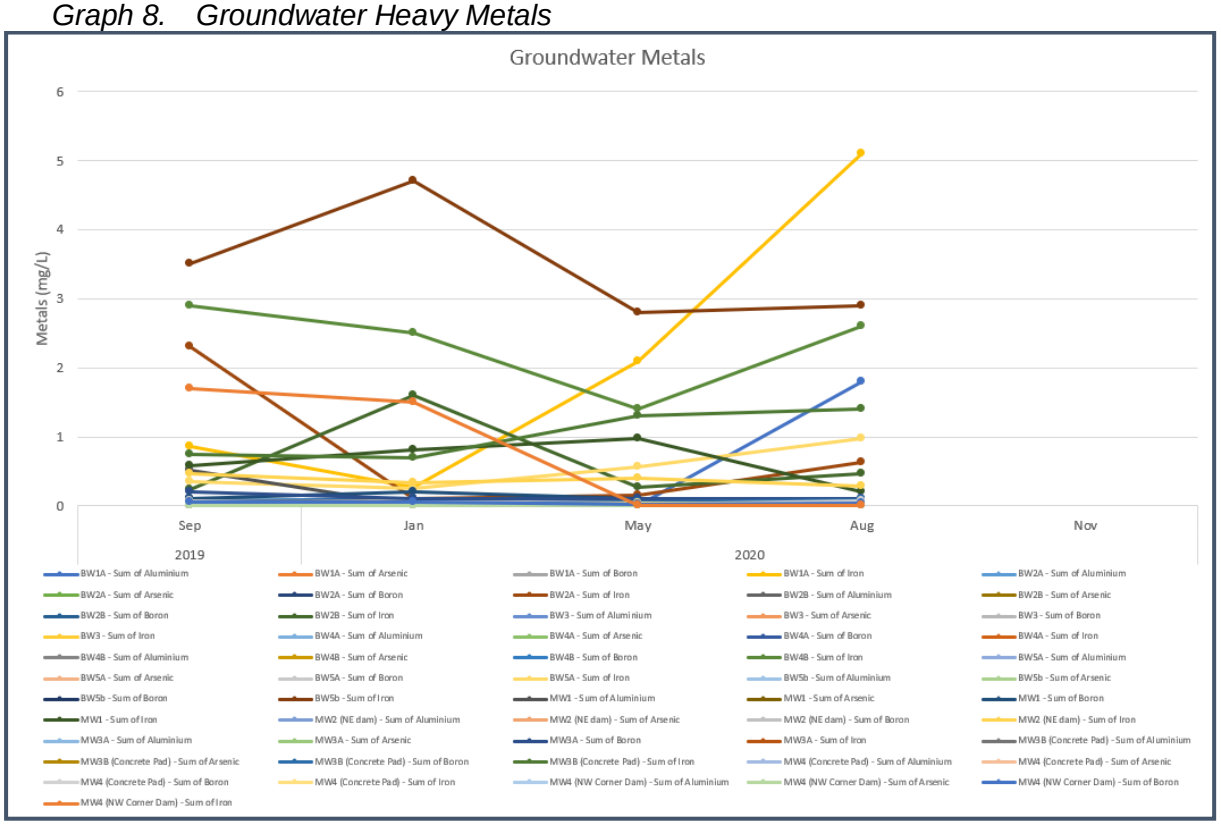
Graph 6. Groundwater Sodium and Potassium



Graph 7. Groundwater Calcium Magnesium



Graph 8. Groundwater Heavy Metals



The results of the quarterly monitoring have been compared to The Australian and New Zealand Guidelines for Fresh and Marine Water Quality 2018 (ANZG) for 95% protection of aquatic ecosystems. The results are generally within the guideline values, where they are provided. Several metal species exceeded the guideline values. Aluminium is exceeded in MW1 and BW1a on a single occasion each. Copper was repeatedly found in all bores at a level above the criteria, as was Zinc. Manganese was exceeded in bores BW4a and BW1a on occasion, both of which are adjacent to South Creek and Badgerys Creek respectively. Similarly, Nickel is in exceedance a number of times in BW1a, BW2b, BW2a, BW4a, which are all located adjacent to the creeks and distant from the manufacturing facility. These exceedances are attributed to naturally occurring geological strata impacts to the groundwater.

Monitoring for the above analytes will continue on a quarterly basis.

7.5. Alluvial Aquifer Assessment

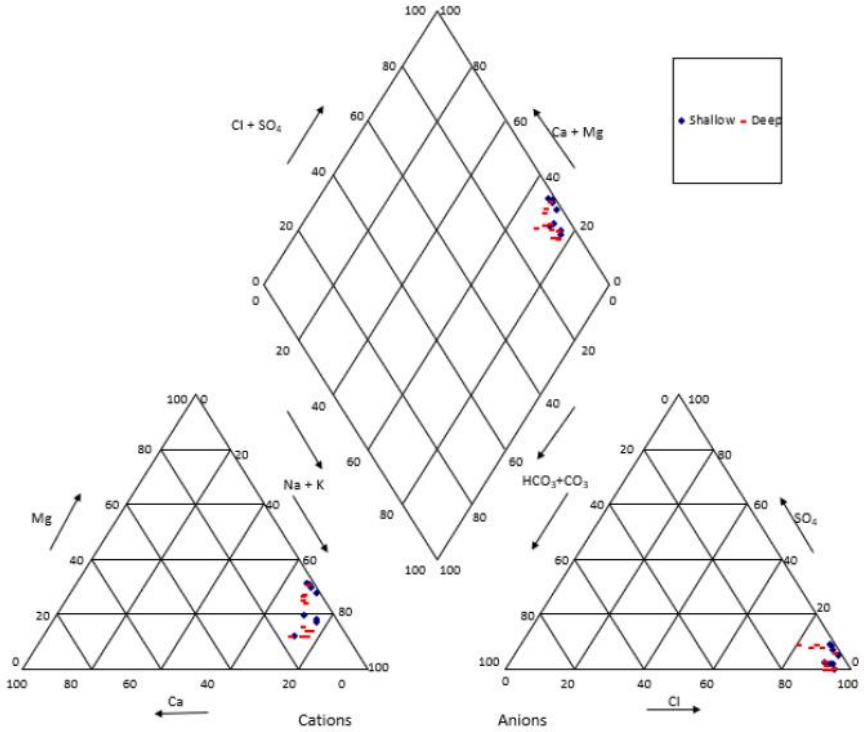
PGH engaged Groundwater Exploration Services Pty Ltd, whose appointment has been approved by the Secretary, to prepare a Groundwater Assessment (see *Appendix I*) which included an Alluvial Aquifer Assessment (AAA) for the project to the satisfaction of the Secretary. This assessment addressed:

- a program to monitor groundwater from boreholes that have been constructed in the alluvial sediments adjacent to Badgerys and South Creeks and their tributaries, and in the Bringelly Shale bedrock aquifer;
- alluvial mapping to delineate the presence and extent of alluvial sediments and alluvial aquifers between Badgerys Creek and the proposed Pit 5 extraction area;
- mitigation and management measures to ensure alluvial sediments and alluvial aquifers are not impacted by the project, including:
  - appropriate buffer setback distances between the alluvial sediments and the Pit 5 extraction area; and
  - any resulting adjustments to the Pit 5 extraction area.

The Assessment has been submitted for approval.

The AAA specified target analytes that would assist in the assessment of recharge-discharge processes and allow for comparison of water sample derived from different environments within the hydrological cycle (see *Section 7.4*). Piper Diagrams were plotted and found that all samples were grouped closely to the right-hand site of the diagram which is indicative of a sodium chloride type groundwater (see *Graph 9*). There is very little variation between shallow and deeper bores. Monitoring will continue as outlined in *Section 7.0*.

Graph 9: Piper Diagram from the Alluvial Aquifer Assessment



The alluvium was mapped in the assessment and the report found very little evidence of an alluvium footprint encroaching beyond the extent of the creek itself. Any flood related deposition appears to be limited to the upper metre of the soil profile and is not saturated or in connection with either creek system. The proposed Pit 5 (now not proceeding) would not have encroached into the alluvium of Badgerys Creek or South Creek and the assessment concluded that there is little chance of impacting on an associated alluvial groundwater resource. The Pit 5 extent did not encroach on the current 60 metre buffer from Badgerys Creek nor did it encroach on the estimated alluvium extent.

8.0 Groundwater Assessment Criteria

Groundwater assessment criteria can only be interim until the baseline data has been established. Initial testing indicates that the groundwater on the site is highly saline, therefore the highest potential for adverse impacts are in rising groundwater table affected soils, and if extraction activities were to contaminate the groundwater table, for example, with oil or fuel spills.

Interim baseline data is summarised below and is based upon the average of results obtained to from March 2018 to August 2020.

Table 27. ***Interim Baseline Groundwater Quality***

Analyte	Units	Average based on all bores	Range of Results	95% Confidence Interval
pH	-	6.8	6.0-10.7	Not Applicable
Electrical Conductivity	µS/cm	15,000	2,660-27,500	13,600-16,600
Total Dissolved Solids	mg/L	12,300	1,340-23,000	10,800-13,800
Total Alkalinity as $CaCO_3$	mg/L	683	160-1,100	595-771
Sulphate as SO_{4-}	mg/L	381	<1-1,300	282-481
Chloride	mg/L	6,010	580-12,000	5,240-6,780
Calcium	mg/L	222	16-620	180-264
Magnesium	mg/L	542	45-1,400	450-636
Sodium	mg/L	3,390	320-6,300	2,960-3,830
Potassium	mg/L	28	2-74	22-33
Aluminium	mg/L	0.048	<0.01-1.8	<0.001-0.119
Arsenic	mg/L	0.001	<0.001-0.005	<0.001-0.001
Chromium	mg/L	<0.001	<0.001-0.005	<0.0001-0.0004
Copper	mg/L	0.085	<0.001-2.50	<0.001-0.187
Lead	mg/L	<0.001	<0.001-0.008	<0.0001-0.0005
Manganese	mg/L	0.814	0.025-3.30	0.608-1.02
Molybdenum	mg/L	<0.001	<0.001-0.002	<0.001-0.001
Nickel	mg/L	0.006	<0.001-0.021	0.004-0.007
Selenium	mg/L	<0.001	<0.001-0.002	<0.0001-0.0001
Silver	mg/L	<0.001	Not Detected	-
Zinc	mg/L	0.061	0.003-0.42	0.042-0.080
Boron	mg/L	0.08	<0.02-0.2	0.05-0.07
Iron	mg/L	0.17	<0.01-5.1	0.66-1.34

Analyte	Units	Average based on all bores	Range of Results	95% Confidence Interval
Benzene	µg/L	Not detected	Not detected	-
Toluene	µg/L	Not detected	Not detected	-
Ethyl Benzene	µg/L	Not detected	Not detected	-
m+p-xylene	µg/L	0.1	<2-3	Not detected - <2
o-xylene	µg/L	Not detected	Not detected	-
Naphthalene	µg/L	Not detected	Not detected	-
TRH C6 - C9	µg/L	<10	<10-20	Not detected - <10
TRH C10 - C14	µg/L	6	<50-150	Not detected - 51
TRH C15 - C28	µg/L	15	<100-190	Not detected - 99
TRH C29 - C36	µg/L	7	<100-380	Not detected - 111
TRH C6 - C10	µg/L	0.5	<100-23	Not detected - 111
TRH C6 - C10 (less BTEX)	µg/L	0.4	<10-19	Not detected - <10
TRH >C10 - C16	µg/L	6	<50-120	Not detected - 66
TRH >C16 - C34	µg/L	24	<100-540	Not detected - 249
TRH >C34 - C40	µg/L	Not detected	Not detected	-
TRH >C10 - C40 (sum)	µg/L	30	<100-540	Not detected - 301

As more data becomes available, trigger levels will be further refined, and the Groundwater Management Plan updated accordingly.

Table 28. ***Interim Groundwater Assessment Criteria***

Parameter	Trigger Level for Investigation	Responsibility/Action
Depth below ground level	Change of greater than 10% from previous recordings that is not related to rainfall	HSE Officer / Investigate root cause, notify in accordance with CSCP
pH	pH outside the range of 6.5 to 8.0	HSE Officer / Investigate root cause, notify in accordance with CSCP
Electrical Conductivity	Greater than 28,000µS/cm	HSE Officer / Investigate root cause, notify in accordance with CSCP
Dissolved Metals	Levels change to greater than 30% when compared to background levels.	HSE Officer / Investigate root cause, notify in accordance with CSCP
Petroleum Hydrocarbons	Change of greater than 30% over background readings	HSE Officer / Investigate whether a spill has occurred, or source is off site. Notify in accordance with CSCP.

9.0 Response Plan for Exceedances of Performance Criteria

9.1. Environmental and Rehabilitation Risk Assessment

A risk assessment of water management issues has been undertaken in accordance with standard risk assessment practices outlined in ISO 31000.2009 *Risk Management – Principles and Guidelines*. The Consequence/Likelihood Matrix has been used with the following scale definitions:

Table 29. *Consequence/Likelihood Matrix*

			Consequence				
			1	2	3	4	5
			Insignificant	Minor	Moderate	Major	Severe
Likelihood	E	Almost Certain	IV	III	II	I	I
	D	Likely	IV	III	III	II	I
	C	Possible	V	IV	III	II	II
	B	Unlikely	V	IV	III	III	II
	A	Rare	V	V	IV	III	II

Likelihood Scale

E	Almost Certain	Expected to occur within weeks
D	Likely	Will probably occur, has happened within recent months
C	Possible	Might occur at sometime within next 2-3 months
B	Unlikely	Could occur within 6-12 months although unlikely
A	Rare	Might occur at some time in exceptional circumstances

Consequence

5	Severe	Irreversible long term environmental harm.
4	Major	Prolonged environmental impact with significant remedial measures required.
3	Moderate	Moderate environmental impacts with immediate remedial measures effective.
2	Minor	Minimal environmental harm with minor remediation activities
1	Insignificant	Little or no environmental harm. Remediation not required.

A summary of hazards or threats identified for the site water management is given below, along with a risk assessment. A Trigger Action Response Plan (TARP) has been developed (see Section 4.4 and 8.0). A TARP identifies proposed contingency strategies in the event of unexpected variations in performance outcomes. These risks have been determined on the assumption that procedures and mitigation measures outlined in this report and other standard procedures that could be reasonably expected have been undertaken.

Table 30. ***Analysis of Water Management Threats***

Water Management Threat	Potential Adverse Outcome	Likelihood	Consequence	Risk
Overland flows from clean water catchments on the site are not consistent with the baseline ecological, hydrological and geomorphic conditions of the surrounding environment.	Significant variation from baseline riparian vegetation condition.	Rare	Insignificant	V
	Significant variation in baseline channel morphology.	Rare	Insignificant	V
Sediment dams overtop into the Badgerys or South Creeks.	The site is a source of water pollution adversely impacting aquatic ecology.	Rare	Minor	V
	Significant variation from baseline riparian vegetation condition.	Rare	Minor	V
	Significant variation in baseline channel morphology.	Rare	Minor	V
The landform, whether through extraction or rehabilitation activities, is not properly protected from erosion.	The landform is a source of pollution due to sediment entrainment adversely impacting aquatic ecology.	Unlikely	Minor	IV
There is the potential for spills and contamination by metals and hydrocarbons from machinery and waste disposal.	Contamination of groundwater and/or impact on Groundwater Dependant Ecosystems	Rare	Minor	V
The development encroaches into the alluvial aquifer.	Loss of integrity of the aquifer	Rare	Minor	V

Monitoring of water quality has occurred consistently since 2017, with very little data available prior to that date. At this stage monitoring of Badgerys Creek water quality is to provide background data for establishing performance criteria and it has been noted that the water quality in Badgerys Creek is inconsistent. As the site is not discharging the variability of the water quality is not due to the site operations but rather due to variations in rainfall, stream flow and other upstream influences. For this reason, monitoring will continue to ascertain the baseline variations.

Similarly, no monitoring of the creek health has been undertaken to date and consequently no baseline data on the vegetation and morphology of the creek is available.

Possible responses to exceedances are outlined in the table below. Further refinements of responses will occur once sufficient baseline data has been obtained. Any exceedances recorded will be reported through the Annual Review.

10.0 Reporting Protocol and Contingency Planning

Reporting Protocols are described within the Environmental Management Strategy and are not included in this report.

The results of investigations and subsequent implementation of controls, safeguards and management measures will be integrated into the overall quarry Environmental Management System to minimise the potential for future occurrences.

10.1. Non-compliances and Exceedances of Performance Criteria

In the event of any incident, non-compliance or exceedance of performance criteria, DPIE will be notified immediately along with any other relevant agency such as the EPA and NRAR. Further investigation by an appropriately qualified representative, will be initiated to characterise the source of exceedance and to recommend and implement solutions to mitigate any potential impacts. Additional monitoring may be required to identify the source of the impact and monitor the effectiveness of the remedial solution. An Incident Report will be submitted within 7 days in accordance with the procedures outlined in the EMS and the Community and Stakeholder Consultation Plan.

Consultation will be undertaken with authorities to notify them of any breaches to any regulatory requirements applicable to the Site as well as in the development of remedial strategies.

The results of investigations and subsequent implementation of controls, safeguards and management measures will be integrated into the overall quarry Environmental Management System to minimise the potential for future occurrences.

10.2. Emergency Incident Plan

Incidents and non- compliance reporting are described within the Environmental Management Strategy and PIRMP and are not included in this report.

Similarly, complaints will be addressed through the site complaints register as described in the Environmental Management Strategy.

11.0 Plan Review and Implementation

11.1. Review

Water management actions included within this Plan will be reviewed annually and updated where necessary. The ARR will provide the main mechanism for driving continual improvement in the performance of the Site. A review will also be undertaken within 3 months of the following:

- the submission of an annual review of the Environmental Management Strategy (EMS);
- the submission of an Incident Report;
- the submission of an audit report;
- any modification to the conditions of approval (unless the condition requires otherwise); or
- Prior to commencing excavations in a new pit.
- Amending the Dewatering strategy of the site

This is in accordance with the intent of the conditions of approval to ensure that strategies, plans and programs are updated on a regular basis, and incorporate any recommended measures to improve the environmental performance of the project.

11.2. Implementation

11.2.1. Responsibilities

The Site Environmental Officer or other suitably qualified delegate will be responsible for the implementation of the requirements of this Plan.

11.2.2. Allocation of Resources

Resources and materials will be allocated to the timely implementation of actions documented within this Plan. Resources and materials will also be allocated for the routine and emergency maintenance of environmental protection works.

11.3. Induction and Environmental Awareness Training

11.3.1. Site Induction

Environmental matters will be highlighted in the site induction for all personnel, including subcontractors. Staff will be made aware of their responsibilities under relevant environmental legislation.

11.3.2. Training

Informal training of water management issues applicable to the Site will be undertaken with site personnel.

12.0 References

Ref. 1. AECOM. (November 2010). Badgerys Creek Environmental Assessment for Continued Operation of Quarry and Brick Making Facility.

Ref. 2. AECOM Australia (AECOM), (2010). Environmental Assessment – Appendix C: Soil and Water Management Plan: Addendum Soil and Water Management Plan. AECOM Australia, NSW, May 2010.

Ref. 3. Element Environment. (2017). Badgerys Creek Brick Making Facility Modification 2 Environmental Assessment.

Ref. 4. ERM (2002). Soil and Water Management Plan: Badgerys Creek Brickworks Soil and Water Management Plan. ERM, NSW Australia, October 2002.

Ref. 5. Crossmuller (2017) Pit Volume Survey Report CSR Badgerys Creek.

Ref. 6. Department of Environment and Climate Change NSW (2008) Managing Urban Stormwater: Soils and Construction. Volume 2E Mines and Quarries. NSW, Australia.

Ref. 7. Fulton, A. (Jan 2019). Technical Report Groundwater Assessment, CSR Advanced Manufacturing Hub, DRAFT.

Ref. 8. High Definition Design Pty Ltd (2020) Detention Basin Design Option Drawings

Ref. 9. Hyder Consulting Pty Ltd. (11 April 2013). Badgerys Creek Brickworks Water Management plan

Ref. 10. Landcom (2004) Soils and Construction: Managing Urban Stormwater. Volume 1. NSW, Australia.

Ref. 11. NSW Department of Planning and Infrastructure (DoPI), (2011). Project Approval No 10_0014. NSW Government, Sydney, September 2011.

Ref. 12. NSW Department of Planning and Infrastructure (DoPI) (2011a). Major Project Assessment: Boral Badgerys Creek Quarry and Brick Making Facility (10_0033 and 10_0014), September 2011.

Appendix A: Figures

Appendix B: Erosion and Sediment Control Checklist

Appendix C: Consultant Approval

Appendix D: Blue Book Calculations

Appendix E: DPIE-Water Correspondence

Appendix F: Liverpool Council Correspondence

Appendix G: Dewatering Infrastructure Plan

Appendix H: Dewatering Management Plan

Appendix I: Technical Report- Groundwater Assessment