Appendix A

Water impact assessment

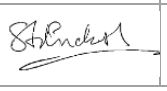
Lake George Mine Remediation Works Addendum REF

Water Impact Assessment

Department of Regional NSW

14 December 2022

→ **The Power of Commitment**

Project name		Lake George Mine Remediation Works Addendum Review of Environmental Factors					
Document title		Lake George Mine Remediation Works Addendum REF | Water Impact Assessment					
Project number		12551771					
File name		12551771-Lake George Mine Remediation-REF-Addendum-AppendixA-WIA-Rev0-tracked-changes.docx					
Status Code	**Revision**	**Author**	**Reviewer**		**Approved for issue**		
			Name	**Signature**	**Name**	**Signature**	**Date**
S3	A	Arielle Patapanian Tom Darley	Tom Patterson	On file	Stuart Winchester	On file	18/11/2022
S4	0	Arielle Patapanian Tom Darley	Tom Patterson		Stuart Winchester		14/12/2022

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1. Introduction

1.1 Project overview

Since 2017, GHD Pty Ltd (GHD) has been assisting the NSW Legacy Mines Program (LMP) within the NSW Department of Regional NSW with various work packages to advance the Lake George Mine Major Remediation Project (the Project), located immediately to the west of the township of Captains Flat, New South Wales (NSW).

In April 2022, the Department of Regional NSW approved the Review of Environmental Factors (REF) document (GHD, 2022- hereafter referred to as the original REF) prepared to assess the proposed remedial works through a self-assessment under Part 5.1 of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act). The original REF assessed the design of the Project as described in Chapter 4 of the original REF. The proposed remedial work previously assessed in the original REF Water Impact Assessment (WIA) was in relation to the exposed, or partly vegetated contaminated soil in the Rail Loading, Creeks, Railway Precinct, Old Mill and Mill Areas, and the exposed waste rock and mineralised *in situ* rock in the Central and Elliot's Mine Area. The original WIA considered the existing contamination sources and pathways at the site and overall long-term benefits the remediation works would result in.

Following the original REF approval, the LMP identified some modifications to the approved Project that require assessment and approval under the EP&A Act. These modifications include additional remediation works in and around Copper Creek, Forsters Creek and the Molonglo River, culvert upgrades/additions, a new middle sediment basin, construction wastewater treatment for on-site reuse, reuse of green waste onsite, and other changes to the proposal following completion of the original REF (refer Section 2). These additional works were not considered in the original REF.

An addendum to the REF is being prepared (hereafter referred to as the Addendum REF), and this WIA considers impacts arising from the proposed modification works. This WIA report is an appendix to the Addendum REF.

1.2 Scope of this report

This WIA report provides an assessment of potential impacts of the modifications to the approved Project and has been prepared to support the Addendum REF in accordance with Part 5.1 of EP&A Act. This WIA addendum describes and assesses only those aspects of the approved Project that have changed since determination of the original REF. To obtain an understanding of the wider water impacts of the approved Project, this WIA addendum should be read in conjunction with the original REF, including the previous WIA.

This document, has been prepared with reference to ESG2: Guideline for preparing a Review of Environmental Factors (NSW Government, 2015), and should be read in conjunction with the Addendum REF.

1.3 The proponent

The proponent for the proposed modification is the NSW Legacy Mines Program within the NSW Department of Regional NSW. The Department of Regional NSW is a central agency within the NSW Government, which covers a range of regional issues, including the state's mineral and mining resources. The Department of Regional NSW hosts the Legacy Mines Program, which delivers works to reduce the risk from legacy mine sites which are commonly historic and abandoned, where no person or company is responsible for the rehabilitation.

1.4 Site location

The Lake George Mine is located adjacent to, and directly west of the township of Captains Flat within the Southern Tablelands of NSW. It is about 50 kilometres south-east of Canberra and is adjacent to Captains Flat Road. The proposal site includes several areas within the Lake George Mine (refer to Figure 2.1).

The locations of the proposed modifications are also shown on Figure 2.1.

1.5 Structure of report

This report is structured as follows:

– Section 1: Outlines the Project overview, introduces the proposal, and outlines the scope of this report
– Section 2: Summarises the modification proposal
– Section 3: Outlines the assessment methodology and describes the procedures to identify impacts and determine whether mitigation measures will be required, during both construction (remediation) and post remediation
– Section 4: Provides an assessment of impacts to water, including any physical and pollution impacts during both construction (remediation) and post-remediation, as well as presents the mitigation measures and proposed water management strategy developed in response to the impact assessment
– Section 5: Summarises the report.

1.6 Limitations

This report has been prepared by GHD for Department of Regional NSW (Legacy Mines Program) and may only be used and relied on by Department of Regional NSW (Legacy Mines Program) for the scope agreed between GHD and Department of Regional NSW (Legacy Mines Program) as set out in section 1.1 of this report.

GHD otherwise disclaims responsibility to any person other than Department of Regional NSW (Legacy Mines Program) arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

The opinions, conclusions and any recommendations in this report are based on information obtained from, and testing undertaken at or in connection with, specific sample points. Site conditions at other parts of the site may be different from the site conditions found at the specific sample points.

Investigations undertaken in respect of this report are constrained by the particular site conditions, such as the location of buildings, services and vegetation. As a result, not all relevant site features and conditions may have been identified in this report.

Site conditions (including the presence of hazardous substances and/or site contamination) may change after the date of this report. GHD does not accept responsibility arising from, or in connection with, any change to the site conditions. GHD is also not responsible for updating this report if the site conditions change.

GHD has prepared this report on the basis of information provided by Department of Regional NSW (Legacy Mines Program) and others who provided information to GHD (including Government authorities), which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

2. Project description

2.1 Proposed modifications

The following summarises the proposed modifications to the approved Project, as described in the original REF, that are the subject of this WIA:

- An additional location option for the temporary site infrastructure including site office, lunchroom, ablutions block, induction / training room and first aid room (Section 2.3.1)
- Mobile, packaged worker decontamination facilities
- Remedial work in and around Copper Creek, Forsters Creek and the Molonglo River to remediate discrete areas of contaminated surface fill (i.e., a controlled activity (remedial works) on waterfront land as defined under the NSW *Water Management Act* 2000) (Section 2.3.2)
- The addition of culvert works, a clean water diversion drain, and sediment basins for construction water management in the Mill Area and Creeks and Rail Loading Area (Section 2.3.2)
- De-silting of sediment basins and management of the sediment (Section 2.3.2.5)
- Change to construction water management during remedial works including construction of a new basin (Section 2.3.2.5)
- The optional reuse of an existing spoil stockpile as backfill after the removal of a sulfidic waste stockpile in the North Mine Ridge (Elliot's) domain (Section 2.3.3)
- A change in remediation methodology, with respect to retention of heritage items, within the Captains Flat Railway Precinct (Section 2.3.4)
- A change in remediation methodology within the Old Mill Area (Section 2.3.5)
- Green waste generation and disposal during site early works and the clearing and grubbing component of the remedial works (Section 2.3.6)
- Minor road maintenance work (Section 2.3.7).

As a result of the above, minor changes to the previously approved boundary for the maximum extent of site remedial works are required.

Further information regarding these changes is provided in the following sections. Design relevant to the above are provided in Attachment 1.

2.2 Location

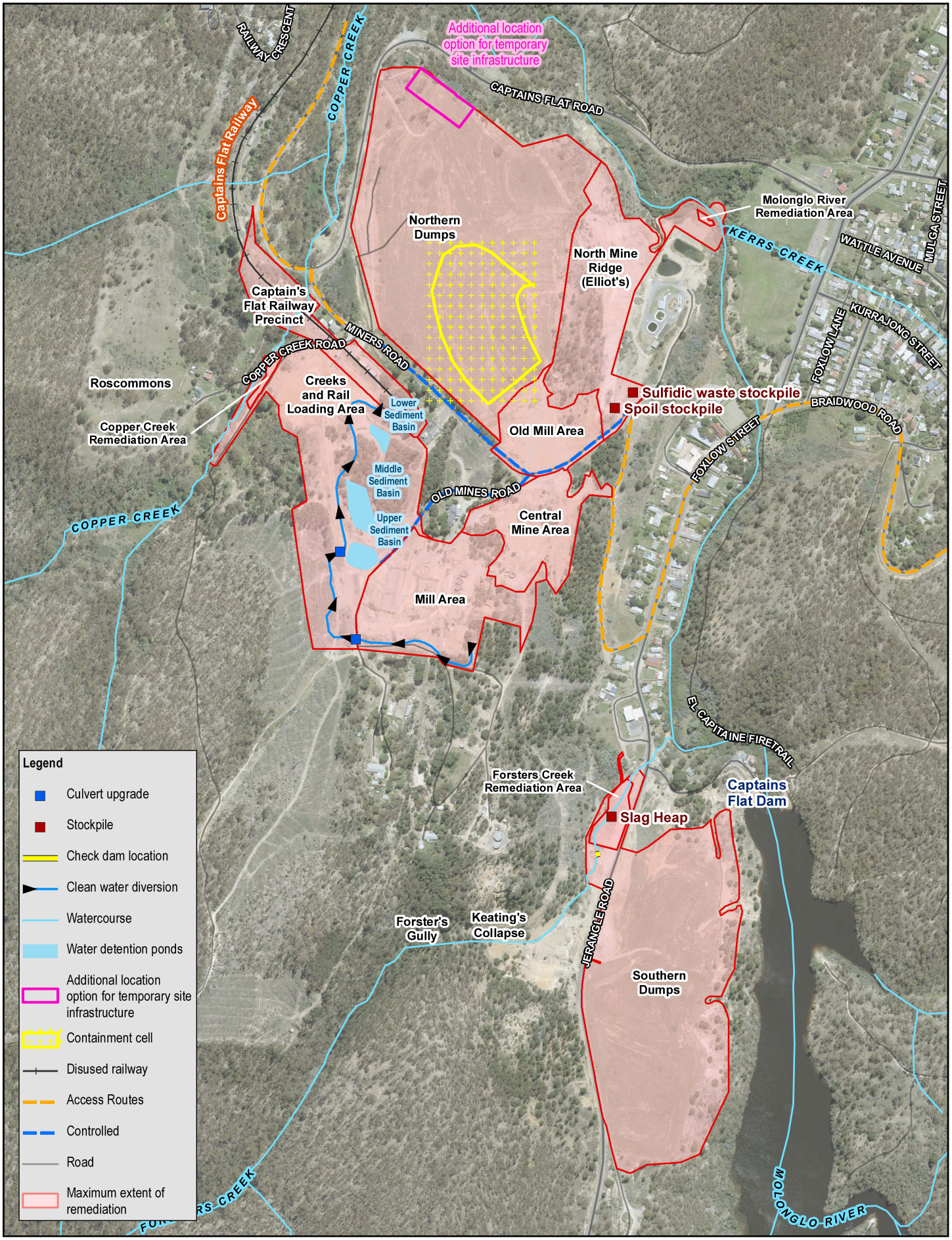
The locations of the proposed modifications are shown in Figure 2.1, which also shows the slightly revised maximum extent of remediation.

2.3 Description of modifications

2.3.1 Additional location option for temporary site infrastructure

The original REF included two options for the location of the temporary site infrastructure that included a site office, ablutions block and other facilities - being the NSW State Emergency Services building (the preferred option) and / or at the mine lookout parking area.

The amendment includes a third option for the location of the temporary site infrastructure, being at the northern extremity of the Northern Dumps, as shown in Figure 2.1. The temporary site infrastructure itself remains unchanged from the approved REF.



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Key features of the revised proposal

FIGURE 2.1

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2.3.2 Remedial work in waterfront land

The approved Project included remedial work to the bank of Forsters Creek, however, did not include works on waterfront land at Copper and Forsters Creeks, nor the Molonglo River.

The remedial works are deemed to be a controlled activity on waterfront land as defined under the NSW *Water Management Act 2000*.

The proposed remedial works, as shown in Figure 2.2, are described below.

2.3.2.1 Copper Creek

The approved Project included remedial works adjacent to Copper Creek within the Creeks and Rail Loading Area, however, remedial works to the south-eastern bank of Copper Creek were excluded. Remedial works on waterfront land are now proposed.

The remedial work in Copper Creek would involve excavation of contaminated material on the south-eastern bank as shown indicatively in Figure 2.2. Contaminated material would be removed from the bank, remaining in situ soils lime-treated, and engineered rip-rap installed. Engineered rip-rap would be recessed such that no net-filling in the flood plain is required.

The only scenario where works within the baseflow channel are anticipated is where riprap for the bank stabilisation cannot be tied into *in situ* rock or stiff clay.

Designs for the proposed in stream work in Copper Creek are provided in Attachment 1 and flood modelling informed the choice of rock sizing for the scour bank protection (refer Attachment 2).

2.3.2.2 Forsters Creek

The approved Project included remediation of the slag heap and associated mineral waste material within the Forsters Creek channel.

To enable the full extent of the slag within Forsters Creek to be remediated, mobile plant would need access to the channel bed. To permit these works, a check dam would be installed, with a gravity feed pipe system diverting clean water around the works area. The pipe discharge would be located downstream of the works area prior to the culvert under Foxlow Street.

Slag would be removed to natural bedrock, and where required, the batters and creek line would be re-shaped with existing on-site material to form consistent batters. Finally, the check dam would be released and returned to the natural creek alignment.

The capacity of Forsters Creek would not be reduced by the works, thus flood risk would not be increased.

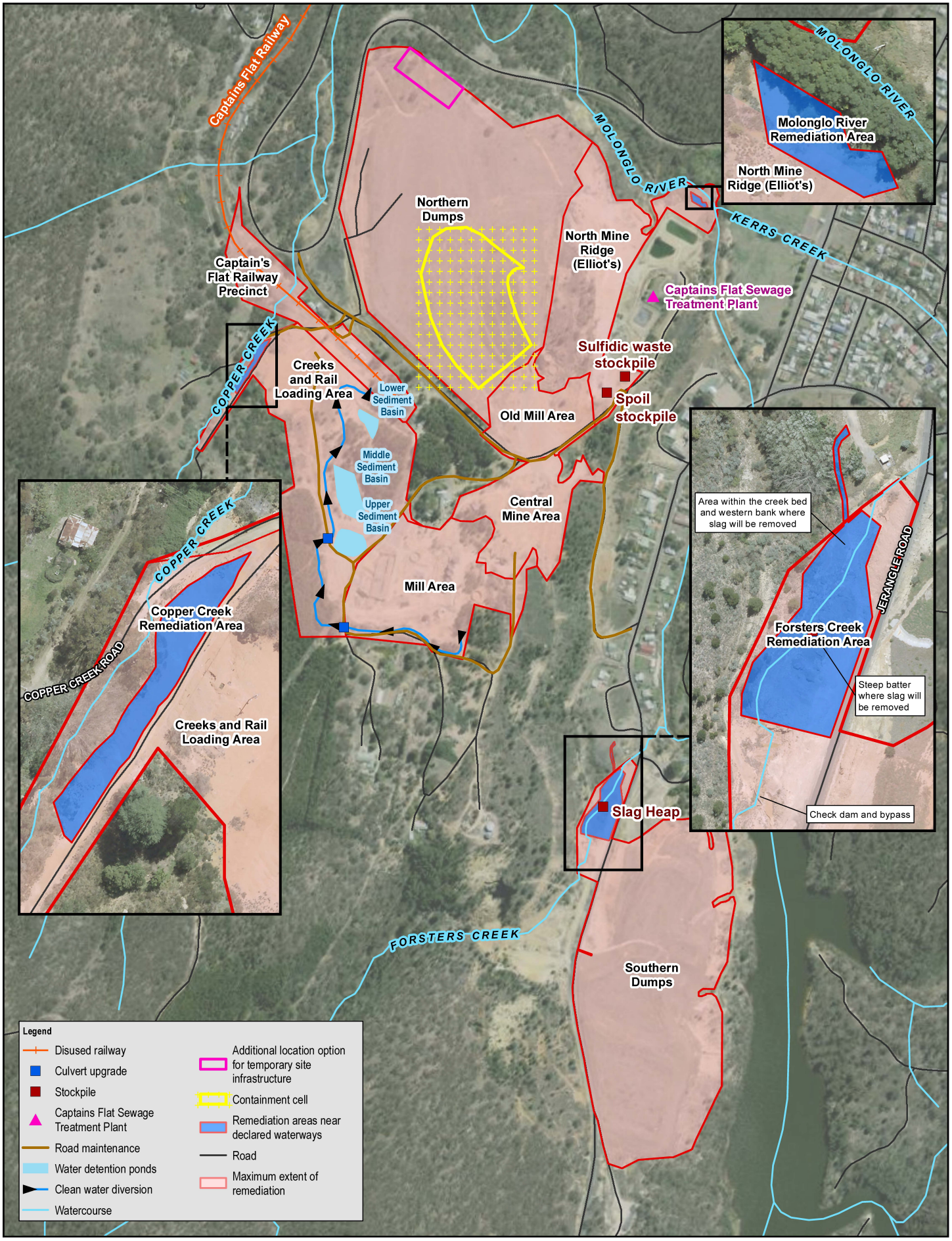
During construction, the construction contractor would engage a suitably qualified geotechnical engineer or engineering geologist to develop and implement suitable controls to manage construction phase stability risks. If excavation identifies that the slag on the road batter exceeds a depth where excavations may undermine and destabilise Jerangle Road or promote excessive erosion and sedimentation risk, then excavation works would be halted. Contingency actions would then be developed and implemented in consultation with a suitably qualified geotechnical engineer or engineering geologist, which would likely involving capping the slag, with appropriate erosion and scouring controls installed.

2.3.2.3 Molonglo River

The southern bank of the Molonglo River immediately to the north of Council's wastewater treatment plant contains a small quantity of contaminated mineral waste and slag.

Works on the Molonglo Riverbank would involve removal of the contaminated material in the area shown on Figure 2.2. Once the contaminated material was removed, site remediation would involve using *in situ* lime neutralisation overlain with geotextile, placed under rock material for bank scour protection. Once remediated, this area would be revegetated as far as reasonably practicable. No net-filling is required.

The capacity of Molonglo River would not be reduced by the works, thus flood risk would not be increased.



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Remedial works on waterfront land

FIGURE 2.2

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2.3.2.4 Culvert upgrade

At two locations, upgrades to existing, or installation of new culverts, are proposed to allow clean water to pass under existing site roads and tracks unimpeded. The culvert works will include upgrades at culvert location 1 and installation at culvert location 2 (refer Figure 2.2) to have both locations accommodate 3 x 600 mm diameter concrete pipes.

2.3.2.5 Construction water basin

A new 2 ML Middle Sediment Basin is proposed between the Mill Area and Rail Loading / Creeks Area to assist with construction water management (refer Attachment 3 for location). Construction of the new basin would require some vegetation clearance.

The new Middle Sediment Basin would be operated in conjunction with the other sedimentation basins during remedial activities. Water collected in the proposed Middle Sediment Basin would be used for construction wastewater treatment as required. This would comprise a staged treatment method using flocculent to remove suspended sediment and some metals followed by pH adjustment (alkalinity) to precipitate metals as metal hydroxides, followed by further pH adjustment (acidity) back to a range suitable for on-site beneficial reuse of the water.

To maximise the capacity of the existing Upper and Lower Sediment Basins, they require de-silting following de-watering to site, or to the newly constructed Middle Sediment Basin. It is proposed that excavated silt be temporarily stored on site in the Mill Area using appropriate erosion and sediment controls until such time that the on-site containment cell is constructed. The thermally dried, de-silted sludge would then be analysed for contaminants before being stoichiometrically lime amended and placed in the containment cell for long term storage along with the remainder of the sulfidic mineral waste to be excavated and removed from the Mill Area.

2.3.2.6 Clean water diversion channel

A clean water diversion channel is proposed to divert run-on from upslope of the Mill Area around the western edge of the Mill Area, through the Rail Loading / Creeks Area and off site (refer Attachment 3 for location). The purpose of the clean water diversion channel is to significantly reduce (~80%) run-on into the contaminated Mill Area to reduce the volume of construction water to manage through remedial works. The sediment basins would then be used to manage the construction water running off from the Mill Area.

The clean water diversion channel and sediment basins would remain on site following remedial works to assist with site water management, both in terms of water quantity and quality.

2.3.3 Use of spoil stockpile

The approved Project includes removal of a sulfidic waste stockpile in the North Mine Ridge/Elliot's domain (shown in Figure 2.1) and placement in the containment cell located on the Northern Dumps.

The amendment to the approved remedial strategy for the sulfidic waste stockpile is that the cleared stockpile footprint would be backfilled to grade with material from an existing spoil stockpile located adjacent to the sulfidic waste stockpile (shown in Figure 2.1).

The spoil stockpile was undergoing geochemical analysis at the time of writing the Addendum REF. If the geochemical analysis finds the spoil stockpile to be inert, then it would be used as backfill. Alternatively, if the spoil stockpile is found not to be inert then:

– The sulfidic waste stockpile would be removed and placed in the containment cell
– The area would be remediated with capping Option 2 and or 3, depending on the land grade, in accordance with the original REF
– The spoil stockpile may also be removed and placed in the containment cell, with the area remediated with capping Option 2 and or 3, depending on the land grade, in accordance with the original REF.

2.3.4 Captains Flat Railway Precinct

The original REF assessed remediation works at the Transport for NSW owned land that hosts the Captains Flat Railway Precinct. Changes to these works include:

– The gantry would remain *in situ* during, and following, remedial works. The replica weighbridge that is present on site may be de-constructed before the remedial works and re-constructed after the remedial works.
– The railway line would not be replaced after the remedial works, rather, would be disposed of.
– The Captains Flat Railway Precinct would be backfilled with sub- and topsoil only, rather than railway ballast.

These changes are not anticipated to result in any changes to already-assessed water related impacts and therefore, have not been assessed.

2.3.5 Remediation method in Old Mill Area

The original REF assessed remediation of the Old Mill Area (refer Figure 2.1) using *in situ* liming followed by placement of a 300 mm thick (subsoil (200 mm) / growing media or topsoil (100 mm)) layer. Some of the steeper areas were to be remediated by *in situ* liming then placement of a 300 mm thick rock mulch layer comprising a hard rock drainage aggregate.

It is now proposed that the Old Mill Area be excavated, with the contaminated material stoichiometrically limed and placed into the Northern Dumps containment cell. The Old Mill Area would then be backfilled using sub- and topsoil and revegetated.

These changes are not anticipated to result in any changes to already-assessed water related impacts and therefore, have not been assessed.

2.3.6 Green waste management

The original REF assessed the generation and disposal of waste including excavated spoil, structural waste, and general waste. Green waste would also be produced from clearing and grubbing works, however green waste was not assessed in the original REF, rather, was implicit in the assessment due to its discussion in the appended Technical Specifications.

Green waste generated through clearing and grubbing would be managed as outlined in Section 2.9 of Appendix B (Technical Specification) to Appendix B (Detailed Design Report) of the original REF. Green waste would be reused on site where possible (e.g., chipped wood), or disposed of at a licenced facility. Some supervised and managed burning of cleared pine may also be required in consultation with an agreed method as developed by the LMP, PWC, relevant landholders and Rural Fire Service (RFS).

These changes are not anticipated to result in any changes to already-assessed water related impacts and therefore, have not been assessed.

2.3.7 Road maintenance

The original REF excluded road maintenance activities on site to support heavy vehicle trafficking.

It is now proposed that the following road maintenance activities would occur to further reduce the potential for impacts to air and water quality and improve road safety through improved road stability:

– Repair minor potholes, subsidence, and pavement instability.
– Repair drains next to road pavement. Drain and gutter maintenance may include cleaning sediment from drains, installing rock rip rap scour protection, and repairing existing culverts to be retained.
– Maintain road surface including paved and non-paved (gravel) surface roads. Works may include re-sheeting (gravel) and bitumen sealing.

3. Impact assessment methodology

3.1 Introduction

The Addendum REF assessment methodology, as presented below, was developed on the basis that the original REF involved extensive assessment of potential impacts of the proposed activities, with many of these risks remaining unchanged (or reducing) due to the modification. The assessment methodology notes the existing level of impacts to the environment associated with the site's existing, or baseline, contamination. The impact assessment methodology approach is summarised as follows:

– The nature of the modifications were reviewed with relation to their potential impact on the water management system proposed in the original REF and any additional risks posed.
– The calculations and justifications developed for the original REF were reviewed where required based on the modified works. Aspects of the modifications still appropriately managed through the original REF water management system were noted and it was nominated that the original REF mitigation measures for these aspects are to remain.
– Where the modifications are such that the original REF calculations and justifications no longer demonstrate their appropriate management, re-assessment is required to be undertaken and revised mitigation developed, as outlined in Section 4. It should be noted that the modifications under this category do not necessarily suggest a higher risk than under the current approval, rather they only suggest that proposed changes are significant enough to require reassessment.

3.2 Water sourcing

No significant changes to water sourcing are anticipated for the modification, and therefore, no further assessment was undertaken.

3.3 Storage

Storage of water on-site occurs within environmental basins and tanks in accordance with the *Protection of the Environment Operations Act 1997*, to manage sedimentation and enable environmental controls and civil works. A new 2 ML basin is proposed to better manage construction water, however, is not anticipated to interact with other external water storages.

No significant impacts on external water storages are anticipated for this modification, and therefore, no further assessment was undertaken.

3.4 Hydrology

Changes to natural water bodies, wetlands and runoff patterns are detailed in Table 3.1, along with commentary on the assessment methodology and outcomes. Potential hydrologic impacts for the modification are assessed against river flow objectives specified in Table 3.1.

Table 3.1 River flow objectives

Objective	Comments
Protect natural water levels in pools of creeks and rivers and wetlands during periods of no flows	No change to river flow objectives is anticipated, as changes to runoff patterns are not anticipated to affect regional hydrology. Remedial works are proposed within Forsters Creek where civil plant and equipment are required to be located within the creek. Clean water will bypass the works via a temporary upstream check dam; however, no storage of water is proposed, and flow objectives are not anticipated to be influenced by this Project.
Protect natural low flows	
Protect or restore a proportion of moderate flows ('freshes') and high flows	

Objective	Comments
Maintain or restore the natural inundation patterns and distribution of floodwaters supporting natural wetland and floodplain ecosystems	Remediation works within Copper Creek would involve excavation and removal of contaminated material from the southeastern Creek bank. Works would involve removal of contaminated material, followed by lime treatment and placement of engineered rip-rap. No changes to flow objectives are anticipated. Works at Molonglo River would involve removal of contaminated southern bank material with remediation via *in situ* liming overlain geotextile and rock. River flow would not be constrained by the works as the proposed works area is to be situated on an elevated point. Generally, works are on a minor scale compared to the downstream system overall such that measurable change to river flow objectives is not anticipated. Furthermore, works restore conditions closer to those of a natural state which is consistent with the overall Project objectives. Thus, no significant impacts are anticipated with relation to these objectives, and no further assessment was undertaken.
Mimic the natural frequency, duration, and seasonal nature of drying periods in naturally temporary waterways	
Maintain or mimic natural flow variability in all streams	
Maintain groundwater within natural levels and variability, critical to surface flows and ecosystems	Refer Section 3.5.
Minimise the impact of instream structures	A temporary check dam and gravity feed pipe system is proposed to be installed upstream of the Forsters Creek works to divert clean water around the works site. Following completion of works, the check dam would be released, and the creek returned to its natural alignment. Given the relatively small upstream catchment and ephemeral nature of the creek, no significant impacts to river flow objectives are anticipated, and therefore, no further assessment was undertaken.

3.5 Groundwater

The additional works proposed in the Addendum REF pose no further risks to groundwater compared to the original REF. Thus, no further assessment was undertaken.

3.6 Hydraulic fracturing

Hydraulic fracturing will not be used in the proposal. Accordingly, no impacts from hydraulic fracturing are applicable to this Project, and therefore, no further assessment was undertaken.

3.7 Flooding

Along Copper Creek and Molonglo River, proposed works involve placement of rip rap along the riverbank to minimise the risk of scour (refer Attachment 2). For both of the works, no net filling is anticipated, works are minor in scale (i.e., at most approximately 950 m^2 for Copper Creek and 300 m^2 for Molonglo River) and expected duration, and the capacity of the waterways would not be reduced or constrained. On this basis, no significant impacts to flood conditions are predicted. The works located within the Forsters Creek waterway alignment involve a net balance of cut over fill, and thus do not have potential to worsen flooding conditions by 'filling' in the floodplain.

Given the above, no further impacts to flooding are anticipated for the Project modification, and therefore, no further assessment was undertaken.

3.8 Water quality

Within the modification works, there are additional areas and works that pose water quality risks that were not assessed in the original REF. However, these modifications are similar in nature to those previously assessed and pose similar water quality risks. Hence, the methodology for assessing risks to water quality from the modifications will follow what was described in the original REF and involve:

– identifying existing water quality conditions and risks associated with the modification
– qualifying potential long-term changes to water quality

– identifying additional risks during construction, including construction-phase surface water management measures which may need to be implemented to manage risk
– identifying potential mitigation and management measures, including monitoring.

The modification works are ultimately anticipated to provide a long-term improvement to water quality downstream by neutralising and minimising the risk of contaminated runoff and potential sedimentation into downstream waterways. This would result in a long-term environmental benefit, relative to existing conditions, that would counteract any potential minor short-term water quality impacts.

4. Impact assessment and mitigation

4.1 Introduction

Key issues identified in Section 3 are assessed in the following sections, including consideration of potential mitigation measures. The impact assessment is based on the particular changes to water related risks due to the modifications presented in the Addendum REF. Mitigation measures were developed by altering those previously developed in the original REF. All mitigation measures proposed in the original REF are still to be adopted without adjustment, unless amendments are stated in this report.

Identification of impacts focuses on potential changes to the site which may result in incremental impacts above the existing level of contamination. Where mitigation measures are proposed, these are intended to manage a potential impact to a level equal to, or better than, current conditions.

4.2 Surface water quality

4.2.1 Construction phase surface water quality

4.2.1.1 Impact assessment

As previously investigated, there is an elevated risk during construction works that will provide a long-term benefit to water quality outcomes following remediation.

Impacts to water quality from various activities associated with the construction works proposed within the Addendum REF are similar to those previously assessed in the original REF. These activities include:

– Earthworks, excavation, disturbing of soils and mobilisation of plant equipment. These have the potential to mobilise surface sediments resulting in impacts associated with erosion and sedimentation as well as impacts associated with in-situ sediments.
– Handling high-risk material such as those used in the on-site wastewater treatment, liming products, as well as materials involved with the green waste management and onsite reuse.

Erosion, sedimentation, and mobilisation of contaminated material

The remedial works in waterfront land occurring in Copper Creek, Forsters Creek, and Molonglo River, have the potential to increase risk of erosion and sedimentation above existing levels. However, the works have in-built mitigation measures, described below in Table 4.1, which reduce the risk of water quality issues. Additionally, the intention of the remedial works is to reinstate original conditions (prior to contamination). Thus, it is considered that the water quality impacts associated with the remedial works are similar in nature to those previously assessed in the original REF and that similar mitigation measures can apply (refer Section 4.2.1.2).

Table 4.1 Remedial works in waterfront land in-built mitigation measures

Waterway	Water quality risk	In-built mitigation measures and considerations
Copper Creek	Excavation and removal of contaminated southeastern bank material could mobilise contaminated sediment within the waterway.	There are no anticipated works to be completed within the baseflow channel. The only scenario where works within the baseflow channel are anticipated is where riprap for the bank stabilisation cannot be tied into *in situ* rock or still clay. Additionally, works are relatively minor in scale (~950 m^2). Utilisation of previously proposed 'enhanced controls' are considered suitable.
Forsters Creek	Exposing the natural surface by removing historically emplaced material could increase erosion, sedimentation, and mobilisation of contaminated material.	Water is to be temporarily diverted for the duration of the works via a check dam that would be installed upstream of the works, with a gravity feed pipe system to divert clean water around the waters. A new sedimentation basin is proposed to manage areas downstream of the check-dam.
Molonglo River	Removal of the contaminated bank material could mobilise contaminated sediment within the waterway.	The works are relatively minor in scale (~300 m^2) and expected maximum duration of approximately two weeks, including contingency time. Utilisation of previously proposed 'enhanced controls' are considered suitable.

The resulting water quality risks during construction are considered moderate, generally associated with short-term potential risks during the overall construction schedule. Ongoing monitoring and mitigation measures are detailed below in Section 4.2.1.2 and are anticipated to manage any additional risk during the construction phase to a suitable level.

Additionally, the modifications are anticipated to results in a long-term benefit. The clean water diversion channel (described in Section 2.3.2.6), for example, is proposed to significantly reduce (~80%) the run-on into the contaminated Mill Area to reduce the volume of construction water to manage through remedial works. Further, removal of slag and contaminated materials in waterways provides a significant long-term benefit to local and regional water quality.

Handling of high-risk materials with water quality risks

The handling of materials posing a high risk to downstream waterways (excluding those associated with typical erosion and sedimentation hazard) is required to permit construction of the Project. Potential activities where handling of high-risk materials could occur, may include:

– The neutralisation of acidic mineral waste and soils while using liming products at Copper Creek and Molonglo River. Over application of liming products has the risk to result in alkaline runoff.
– Construction water on-site treatment using flocculation and pH adjustment.
– Green waste management.

The potential impact associated with the handling of these components includes the potential mobilisation into downstream waterways either via direct flow of the material itself, or through washing from either rainfall derived runoff, or from applied water (e.g., during dust suppression). The impacts associated with similar high-risk materials were assessed in the original REF and similar mitigation measures will apply.

4.2.1.2 Mitigation measures

To further reduce the risk of water quality impacts during construction to a level where impacts are negligible, various mitigation measures are proposed. These are focused on isolating potential pollution sources and managing potential pollution pathways. The measures are detailed in the following sections.

Construction Environmental Management Plan

As proposed in the original REF, a Construction Environmental Management Plan (CEMP) will be prepared by the Contractor, including a Surface Water Management Plan (SWMP).

An example of a conceptual surface water management layout is shown in Attachment 3. This would be confirmed and updated by the contractor in the Surface Water Management Plan.

The SWMP should include all detail described in the original REF, as well as describing processes for dewatering and desilting the two existing sedimentation basins and for managing any proposed sediment basins required during the works.

Erosion and Sedimentation Controls

To manage the erosion and sedimentation risk during the works, the system of engineered erosion and sedimentation controls proposed in the original REF should be continued. These controls included:

– Maintenance of the drainage network and establishment of temporary clean water drains.
– Engineered controls in accordance with the Blue Book (e.g., erosion matting, sediment fencing, shorter slopes and bunds) in areas where erosion and sediment generated by disturbed areas during construction are unable to be managed effectively through sedimentation basins (refer Attachment 3).
– Management of increased sediment load from enhanced control areas that cannot be feasibly drained to a sediment basin. While the Blue Book suggests that the risk of sediment loading for the proposed remediation works at the site is 'low', enhanced controls can be utilised to manage the areas that cannot be feasibly drained to a sediment basin. This includes the remediation areas that are in proximity to natural waterways, i.e., the proposed remediation works at Copper Creek, Forsters Creek, and Molonglo River. This management method is proposed, as larger impacts associated with the disturbance of the waterway would result from implementing standard erosion and sedimentation controls, than by utilising the suggested 'enhanced controls'. Key mitigation measures outlined in the original REF apply, such as works should not be undertaken when notable rainfall is expected.
– Sediment basins to manage risks for elevated mobilisation of sediment during the works. Sizing of sedimentation basins in accordance with the original REF was undertaken, with sizes shown in Table 4.2. Locations of these indicative basins are shown in Attachment 3.

Table 4.2 Indicative sediment basin sizes

Dam	Catchment Area (Ha)	Minimum Dam Capacity Required (ML)
Existing Upper Sediment Basin	4.5 (revised size)	No change from previous minimum requirements
Existing Lower Sediment Basin	4.6 (revised size)	No change from previous minimum requirements
Proposed Middle Sediment Basin	NA[1] (new basin)	2.0 (new basin)
Proposed Sediment Basin 1	No change	No change from previous minimum requirements
Proposed Sediment Basin 2	No change	No change from previous minimum requirements
Proposed Sediment Basin 3	No change	No change from previous minimum requirements
Proposed Sediment Basin 4	4.2 (revised size)	0.9 (revised size)
Proposed Sediment Basin 5	No change	No change from previous minimum requirements
Proposed Sediment Basin 6	No change	No change from previous minimum requirements
Proposed Sediment Basin 7	No change	No change from previous minimum requirements
Proposed Sediment Basin 8	No change	No change from previous minimum requirements
Proposed Sediment Basin 9	No change	No change from previous minimum requirements
Proposed Sediment Basin 10	0.7 (new basin)	0.2 (new basin)

[1] Proposed middle sediment basin will be additional storage, not impacted by catchment size.

Handling of high-risk materials with water quality risks

As outlined in Section 4.2.1.1, the potential impacts to surface water associated with handling of high-risk materials (such as liming materials, flocculants, pH adjusters, and materials associated with green waste management) includes the potential mobilisation of the materials into downstream waterways.

Mitigation measures to minimise impacts associated with handling high-risk materials should include:

– Scheduling works to avoid forecasted rainfall during handling of high-risk materials
– Bunding of potentially high-risk areas to capture any spills
– Safely storing all high-risk liquids and materials on ground level away from existing stormwater drainage systems and waterways
– Prepare a Pollution Incidence Response Management Plan
– Regular visual inspections of the works area and waterways to identify any potential water quality issues, as per the implementation of the CEMP and SWMP
– Installing and maintaining control measures such as silt fencing
– Using a lower risk liming product (a calcium carbonate based agricultural lime) not anticipated to have any significant impact on water quality, on in-stream works areas which are not slated for clay capping.

Water quality monitoring

Water quality monitoring should be implemented as a mitigation methodology to identify potential deficits in the site's environmental management during construction.

The monitoring program should be undertaken at previous monitoring locations, as proposed in the original REF, using similar analytes to allow for comparison to historical observations. Additionally, the monitoring program should be extended to include two new locations (TARP-4 and TARP-5) as described below. Recommended construction phase monitoring locations are shown in Attachment 3. The additional locations include:

– TARP-4 (On Forsters Creek, north of the Southern Dumps at the entry of the Jerangle Road culvert) at -35.596602, 149.444112
– TARP-5 (On Forsters Creek, west of the Southern Dumps, at the location of the check dam) at -35.597679,149.443370.

Key monitoring results to be assessed during construction with regards to the Trigger Action Response Plan (TARP) remain the same as those suggested in the original REF Water Impact Assessment (GHD, 2022).

Trigger Action Response Plan

A Trigger Action Response Plan (TARP) is proposed to identify trigger values and criteria and provide appropriate response actions if impacts during construction are identified through the monitoring program. The TARP is presented below in Table 4.3 and identifies the minimum responses to a range of triggers. Minor changes have been made from the original REF Water Impact Assessment (GHD, 2022) in the form of specifying rolling 12-month averages at all three TARP trigger levels to provide clarity around statistical calculations.

Historical water quality observations shall be provided to the Contractor for the purpose of this TARP. It should be noted that the TARP should be referenced in the CEMP developed by the Contractor and may involve ongoing liaison with the Principal, as well as with the relevant CQA Engineer and/or Designer authority.

Table 4.3 Trigger Action Response Plan

Trigger Level	Indicator	Response
Trigger Level 1	At least one of the following triggers for two consecutive monitoring events: **pH:** the downstream monitoring point deviates by either more than one standard deviation from the rolling 12-month average of that suitable historic monitoring point and is more than 1 pH unit lower than the upstream location. **TSS:** The downstream monitoring point is greater by 50 mg/L than the upstream monitoring location and/or deviates by more than one standard deviation from the rolling 12-month average of a suitable historic monitoring point. **Metals:** A downstream monitoring point is higher by more than one standard deviation from the rolling 12-month average of that suitable historic monitoring point.	All of the following: Review site housekeeping. Monitor the state of the works during the previous 7-day period, in particular review: – The state of stockpiled materials – Erosion and sedimentation control infrastructure – Signs of erosion and sedimentation – Any exposed waste rock of potential contaminated materials.
Trigger Level 2	At least one of the following triggers: **pH:** The downstream monitoring point deviates by either more than one standard deviation from the rolling 12-month average of that suitable historic monitoring point and is more than 1 pH unit lower than the upstream location over four consecutive weeks. **TSS:** The downstream monitoring point is greater by 50 mg/L than the upstream monitoring location and/or deviates by more than one standard deviation from the rolling 12-month average of a suitable historic monitoring point over four consecutive weeks. **Metals:** A downstream monitoring point is higher by more than one standard deviation from the rolling 12-month average of that suitable historic monitoring point over four consecutive weeks.	All of the following (in addition to Trigger Level 1 Responses): – Undertake a review of the state of the site using a suitably qualified Construction Quality Assurance Engineer, and/or the designer to identify a potential source/pathway attributable to the results – Conduct additional monitoring at the request of the CQA Engineer and/or the Designer.
Trigger Level 3	Both of the following triggers: – Trigger Level 2 occurs for 2 consecutive weeks – A source/pathway cannot be identified following the review of the state of the site.	All of the following (in addition to Trigger Level 1 and Trigger Level 2 responses): – Reconsideration of works staging in consultation with the CQA Engineer and the Principal – Minimise the generation of additional disturbance areas until existing disturbed areas are remediated.

4.2.2 Post-remediation

4.2.2.1 Impact assessment

A key aspect of the proposal is to improve environmental outcomes by reducing risk associated with contaminated runoff and sediment loading from exposed contaminants and disturbed soils at the site.

Improvements to water quality and reduced mobilisation of soils is anticipated to occur through liming, importing sub and topsoils, capping in some instances and revegetating; all acting to stabilise the existing surface and isolate potentially contaminated materials from rainfall derived runoff or infiltration.

Contamination pathways associated with exposed material are anticipated to be significantly reduced, providing a post-remediation improvement in water quality. No significant negative impacts are anticipated.

4.2.2.2 Mitigation measures

Successful long-term water quality improvements anticipated by this Project, are predominantly dependent on the successful construction and maintenance of the works program that includes capping and revegetation. To monitor and manage risk to water quality, the proposed mitigation measures that were previously outlined in the original REF are recommended.

5. Conclusion

The Project is expected to continue to result in a significant improvement to water environments as the surface of the Lake George Mine is progressively remediated. While the construction works associated with the proposed modification have risks that need to be managed, these are not anticipated to significantly increase risk compared to the previously assessed REF. These conclusions are based on the following:

- Existing contamination sources and pathways from the site that pose an existing risk to downstream environments are remediated by the removal of contaminated material, application of in situ treatment, engineered capping, the importation of sub and topsoil and rock mulch, and re-vegetation.
    - The existing risk of erosion and sedimentation is anticipated to be significantly reduced as the site is vegetated.
    - The exposure pathway of rainfall derived runoff and infiltration is anticipated to be significantly reduced as materials are isolated by the revegetation medium and the capping material.
    - The proposed clean water diversion drain will decrease the quantity of construction water to manage, lowering risk of downstream contamination.
- No changes to hydrology or river flows are anticipated, as existing surface water drainage network will be replaced with equivalent structures.
- There is no ongoing water source required, and water demand for construction is to be sourced externally from the Captains Flat town dam or from treated on-site construction water stored in the sediment basins.
- No impacts to flooding, either on-site or off-site, are anticipated as the site is generally above existing flood levels, fill material has been design appropriately considering flood models, and the topology of lower-lying areas is unchanged.
- During the construction phase, a Construction Environmental Management Plan would be prepared following approval of the proposal, in consultation with relevant agencies as required. In particular, the CEMP would include:
    - Implementation of sediment and erosion control devices with consideration to Managing Urban Stormwater, informally known as the ‘Blue Book’, including *Managing Urban Stormwater – Volume 1* (Landcom, 2004), *Managing Urban Stormwater – Volume 2* (DECC, 2008a) and *Managing Urban Stormwater – Volume 2E, Mines and quarries* (DECC, 2008b)
    - Utilising lower risk liming products in all proposed in situ liming areas (other than the ex situ containment cell), namely calcium carbonate based agricultural limes, rather than non-carbonate products such as oxide or hydroxide
    - Stockpiling of potential hazardous materials and emergency management procedures
    - Ongoing monitoring and maintenance during the works, in particular during establishment of vegetation
    - Management and inspection of natural waterways, including Forsters Creek, Molonglo River, and Copper Creek
    - Monitoring of water quality during the works, including consideration of the Trigger Action Response Plan which identifies trigger values and documents appropriate response actions.
- Following construction, continuation of the existing monitoring and maintenance at the site, as part of the site’s post-remediation Environmental Management Plan.

6. References

Australian Rainfall and Runoff (ARR) (2022). *ARR Data Hub,* accessed at Home | ARR Data Hub (arr-software.org)

Catchments & Creeks Pty Ltd (2014). *Rock Sizing for Bank Stabilisation.*

Department of Environment & Climate Change NSW (DECC) (2008a). *Managing Urban Stormwater: Soils and construction - Volume 2B: Waste Landfills.*

Department of Environment & Climate Change NSW (DECC) (2008b). *Managing Urban Stormwater: Soils and Construction – Volume 2E: Mines and Quarries*

Geoscience Australia (2019). *Australian Rainfall & Runoff: A Guide to Flood Estimation*

GHD (2022) *Lake George Mine Remediation Review of Environmental Factors*. Sydney.

ICSM (2022). *Elvis – Elevation and Depth – Foundation Spatial Data,* accessed at: Elvis (fsdf.org.au)

Landcom (2004). *Manual Managing Urban Stormwater: Soils and Construction – Volume 1 (4th Edition).*

NSW Government (1979a). *Environmental Planning and Assessment Act 1979 No 2030.*

NSW Government (1997). *Protection of the Environment Operations Act 1979 No 156*

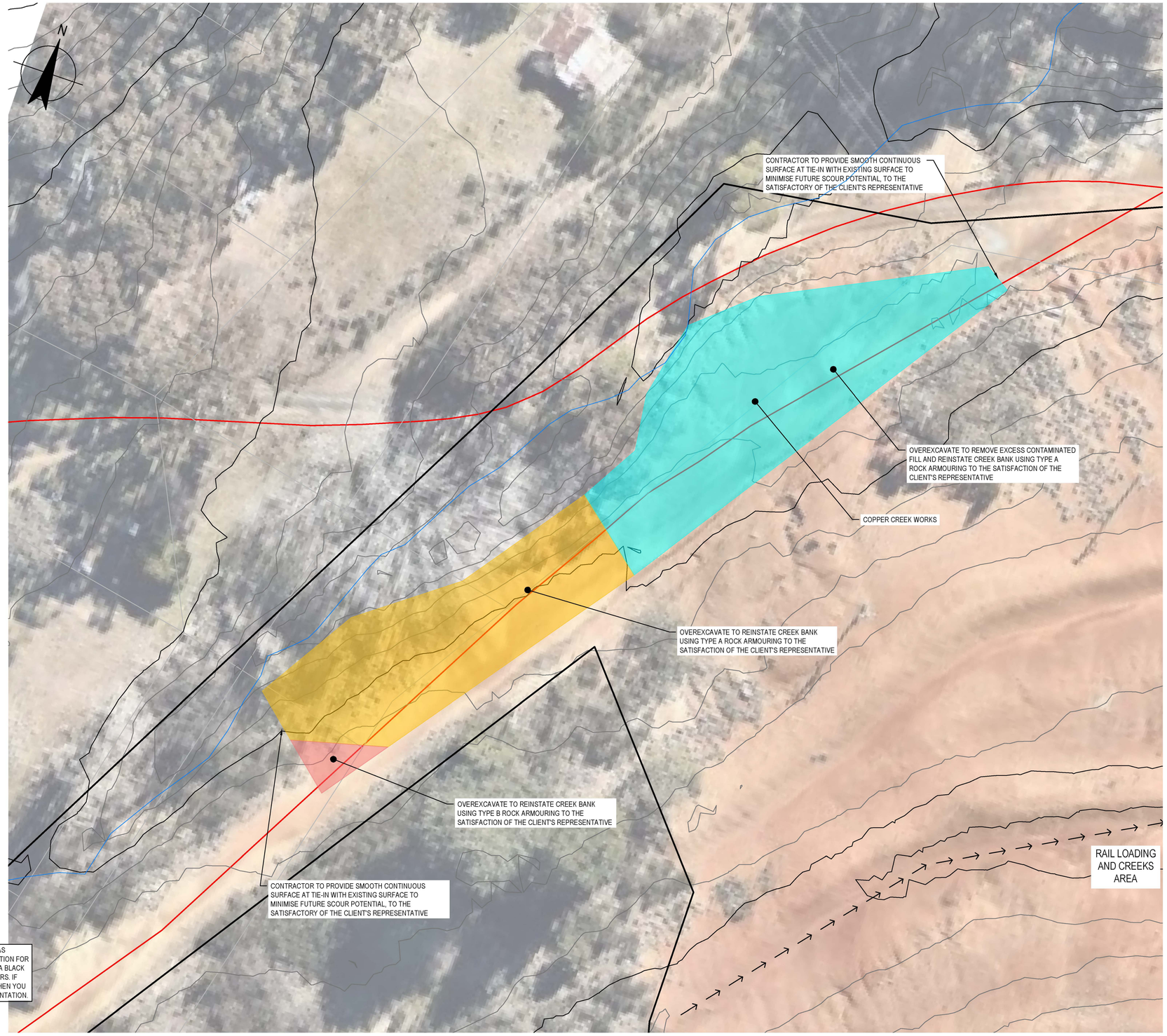
NSW Government (2002). *Water Management Act 2000 No 92*

NSW Government (2015). *ESG2: Guideline for preparing a Review of Environmental Factors*

Office of Environment and Heritage (2019). *Floodplain Risk Management Guide: Incorporating 2016 Australian Rainfall and Runoff in studies*

Attachment 1

Design Drawings



LEGEND

- EXISTING SURFACE
- HYDROLINES
- EXISTING FLOW PATH
- REHABILITATION AND CAPPING EXTENTS

NOTES:

1. REFER NOTES ON DRG. C002 AND C003.
2. EXTENT OF CREEK WORKS AREA TO BE CONFIRMED BY CLIENT'S REPRESENTATIVE AS PART OF SITE ESTABLISHMENT.
3. ALL AREAS ARE APPROXIMATE.

THE ORIGINAL OF THIS DRAWING WAS PRODUCED USING COLOUR SEPARATION FOR GREATER CLARITY. WORKING WITH A BLACK AND WHITE COPY MAY CAUSE ERRORS. IF THIS DRAWING IS NOT IN COLOUR THEN YOU DO NOT HAVE THE CORRECT PRESENTATION.

FOR CONSTRUCTION

Rev	Description	Checked	Approved	Date
0	FOR CONSTRUCTION			

Author R. LOPEZ Drafting Check
Designer E. STUNTZ Design Check

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SCALE 1:250 AT ORIGINAL SIZE

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Project No. 12551771

Client DEPARTMENT OF REGIONAL NSW
Project LAKE GEORGE MINE, CAPTAINS FLAT
Status FOR CONSTRUCTION Status Code S0

Drawing Title CAPPING AND REVEGETATION WORKS
COPPER CREEK WORKS
LAYOUT PLAN

Size A1
Drawing No. 12551771-C018
Rev 0

Plot Date: 12 December 2022 - 10:07 AM Plotted by: Nathan Griffiths
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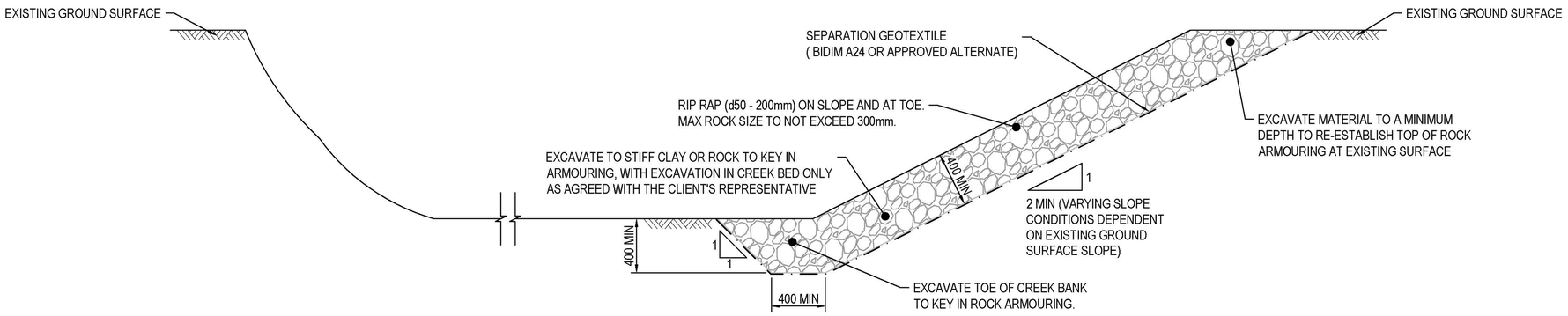

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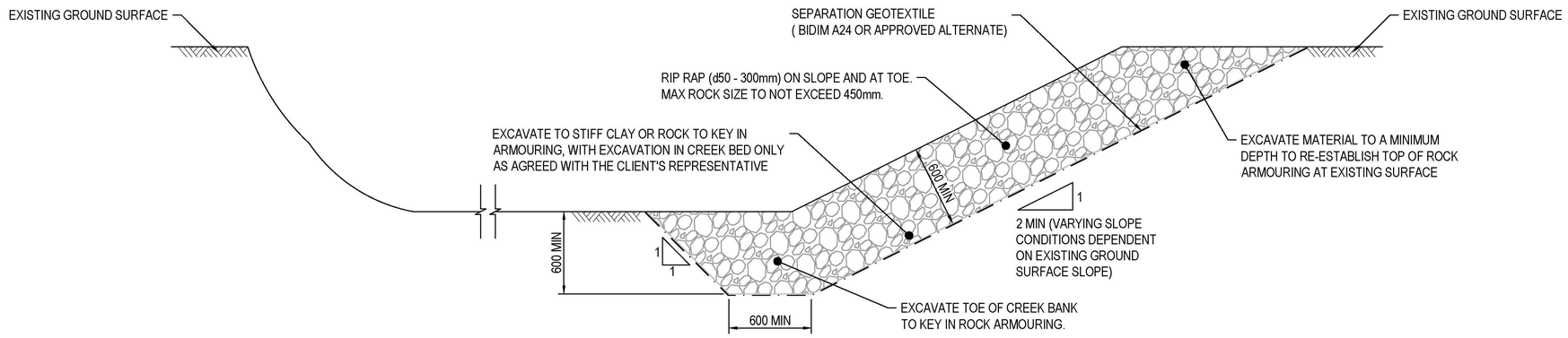

B TYPICAL ROCK ARMOURING - TYPE B
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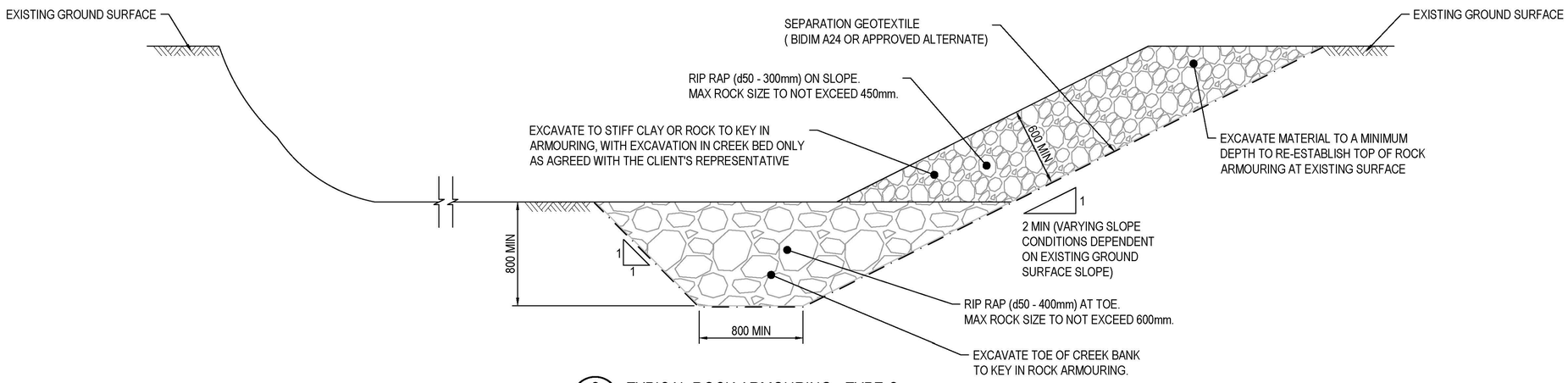

C TYPICAL ROCK ARMOURING - TYPE C
SCALE 1 : 20

FOR CONSTRUCTION

Rev	Description	Checked	Approved	Date
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Author R. LOPEZ **Drafting Check**
Designer E. STUNTZ **Design Check**

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SCALE 1:20 AT ORIGINAL SIZE

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Project No. 12551771

Client DEPARTMENT OF REGIONAL NSW
Project LAKE GEORGE MINE, CAPTAINS FLAT
Status FOR CONSTRUCTION Status Code S0

Drawing Title CAPPING AND REVEGETATION WORKS
COPPER CREEK WORKS
TYPICAL SECTIONS

Size A1
Drawing No 12551771-C019
Rev 0

Plot Date: 6 December 2022 - 3:06 PM Plotted by: Riken Joshua Lopez File Name: \\ghdnet\ghd\PH\Cebu\Projects\21\27816\CADD\Drawings\12551771\Drawings\C011-C019\12551771-C019.dwg

Attachment 2

Basis of Design

2-1 Introduction

Remedial design is required for the proposed remediation works in Copper Creek. Design has been informed by flood modelling and rock mulch sizing calculations and drawings.

Works within Copper Creek involve removing contaminated bank material. Remedial design was required to inform the replacement of material needed to improve the stability of the waterway.

The Forsters Creek and Molonglo River works generally involve removing contaminated materials and are not anticipated to negatively impact waterway stability. As such, no designs for these were works required.

2-2 Basis of design

2-2-1 Hydrology

Compilation

The hydrology of catchments draining from Copper Creek to the Molonglo River (Attachment B Figure 1) were compiled using CatchmentSIM for input into a Watershed Bounded Network Model (WBNM), using methods outlined in Australian Rainfall and Runoff (ARR) 2019 (Geoscience Australia, 2019). Inputs to the WBNM hydrologic model were:

– ARR 2019 rainfall: Intensity Frequency Duration (IFD) Design Rainfall Depth (mm) issued on 19 September 2022 for the requested coordinates: Latitude: -35.5941, Longitude: 149.4313.
– Catchment and impervious areas: The catchment area (375.37 ha with 5.6% average slope) is mostly pervious, with a 5.64% impervious fraction adopted to account for roads, paths, and other less pervious areas.
– Initial and continuing losses: The loss values adopted for the 1 in 20 AEP event were obtained from the ARR 2019 data hub (ARR, 2022), with probability neutral initial losses chosen and a factor of 0.4 applied to continuing losses as per the Floodplain Risk Management Guide (Office of Environment and Heritage, 2019). Continuing losses were taken as 2.80 mm/hr.
– A default lag parameter of 1.6 was taken as recommended by the WBNM manual.
– It is assumed that any dams, lakes and/or reservoirs in the catchment area will be at full supply level, to represent a worst-case flooding scenario.

Simulations were undertaken for the 1 in 20 AEP storm events.

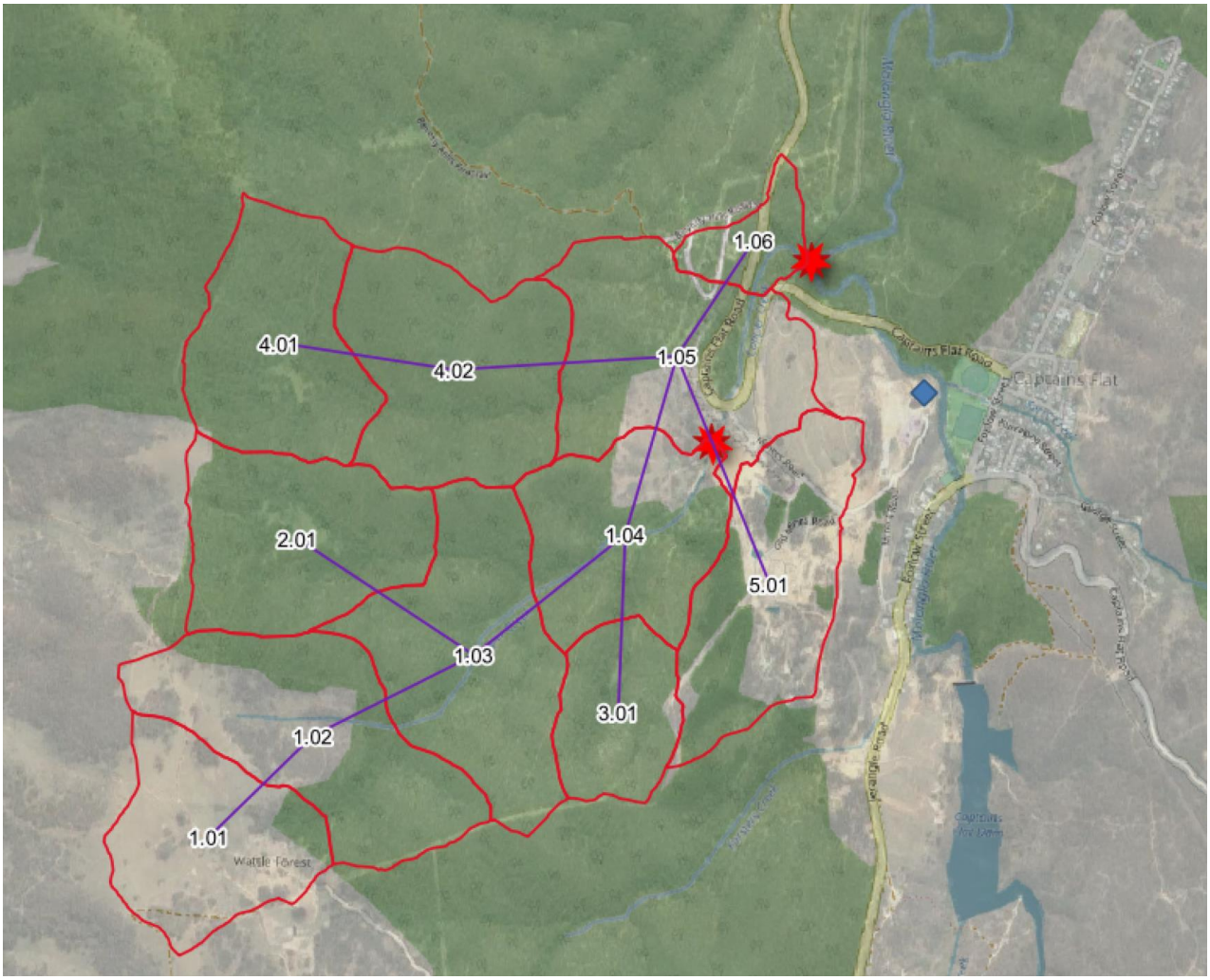
Validation

Validation of the hydrological modelling approach was undertaken against a Regional Flood Frequency Estimate (RFFE). The validation was undertaken by comparing the WBNM model to the RFFE when simulated for the 1 in 100 AEP storm event. The results in Attachment B Table 1 show that the RFFE method provides a wide spread of flood peaks. The catchment size is smaller than the majority of catchments sizes used for the RFFE estimate. However, when factoring the nearest gauged data on catchment areas, a reasonably similar flood peak estimate is noted when compared to the WBNM model.

Based on the above, the WBNM model simulations have been adopted.

Attachment B Table 1 Validation of WBNM Model

Method	1 in 100 AEP Flood Peak (m^3/s)
WBNM	21 (6 hour, median of ensemble)
RFFE	12 to 102 (5% to 95% percentile) 35 (factored by area)



Attachment B Figure 1 Hydrological catchments

For the 1 in 20 AEP event, a range of storm durations were simulated to determine the critical storm duration for the site of interest (red star at outlet of sub-catchment 1.04 in Attachment B Figure 1). The critical duration was used to determine the ensemble that closely approximate the median flood peak. The adopted flood peak results are tabulated below.

Attachment B Table 2 Adopted Flood Peaks

Event	Critical Duration	Median Flood Peak (m^3/s)	Ensemble Number
1 in 20 AEP	4.5 hour	7.9	8

2-2-2 Flood Model

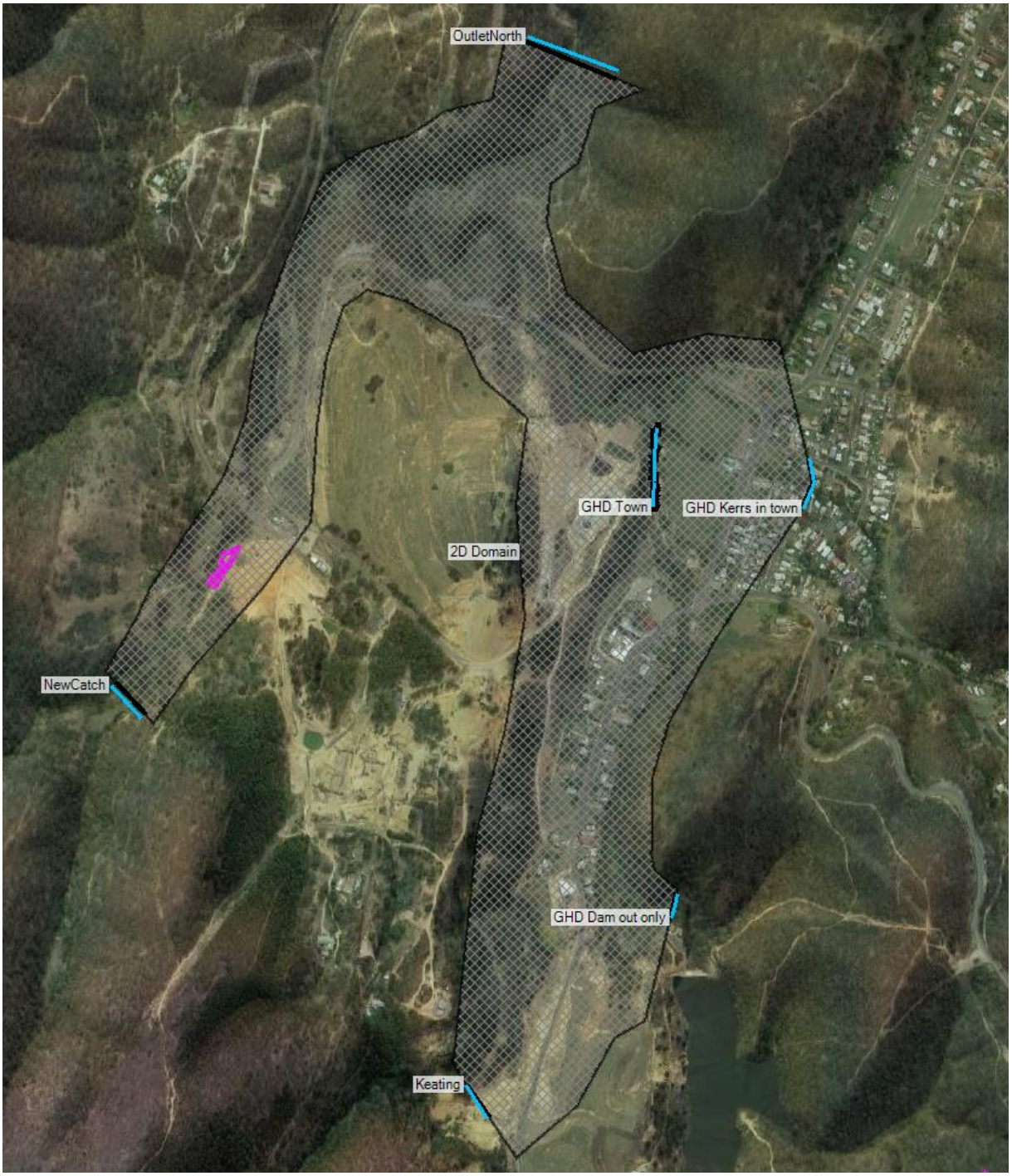
Compilation

The existing HECRAS 2D model (2D flexi-mesh) was updated with the new hydrology for the Copper Creek catchment. The hydraulic model domain is shown below in Attachment B Figure 2.

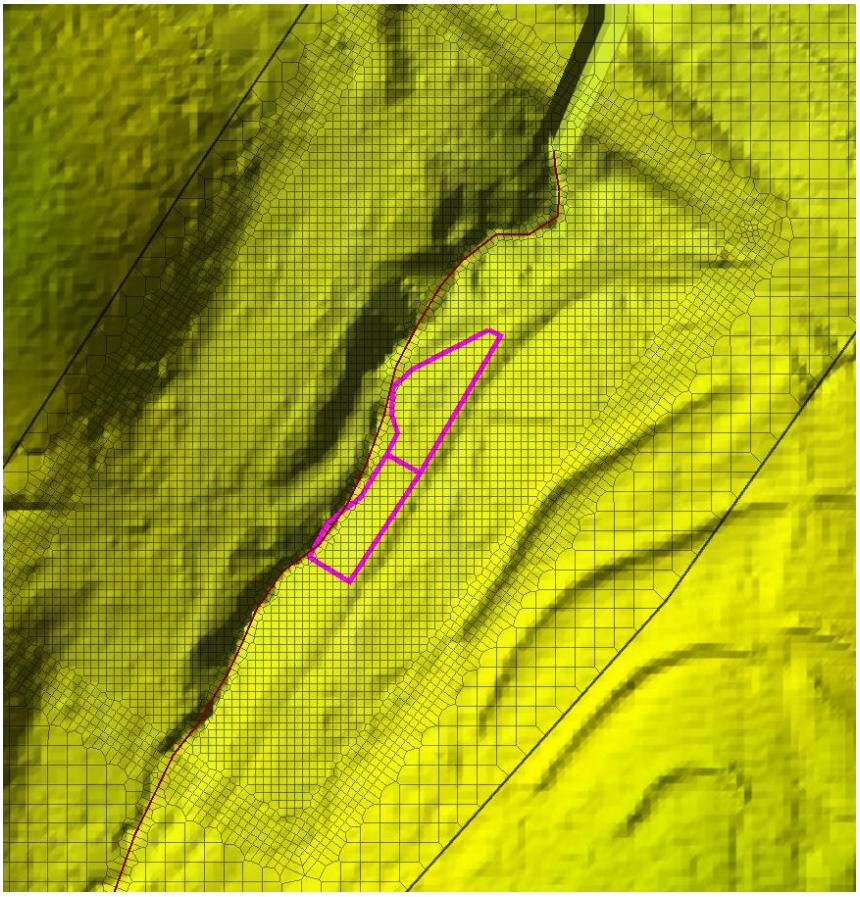
– The general mesh size for the model domain was 5 m. The mesh size was adjusted using break lines in key locations and a refinement region was added at the site of interest which reduced the mesh size to 2 m. For each mesh face HECRAS 2D samples a large number of points, providing a better representation than a regular grid model such as TUFLOW.
– A Manning's "n" roughness value of 0.04 was adopted based on topographical observations.

– Topographic data was sourced from LiDAR data (2 m grid) obtained from the ICSM, ELVIS - Elevation - Foundation Spatial Data portal (ICSM, 2022).
– The WBNM inflow hydrograph was adopted as the upstream boundary condition inflow on Copper Creek.

Simulations were undertaken for the 1 in 20 AEP event and results from the HECRAS model were extracted to inform rock armouring design for the Copper Creek bank outlined in Attachment B Figure 3 by the pink polygon.



Attachment B Figure 2 HECRAS 2D Model Domain



Attachment B Figure 3 Typical sub-grids at the site

2-2-3 Channel Armouring

Channel bed scour protection for the Copper Creek bank has been developed using the updated flood modelling results described above, and per guidance in *Catchments & Creeks Rock Sizing for Bank Stabilisation, 2014* (Catchments & Creeks Pty Ltd, 2014), section 5.

The rock armouring design considered scour protection at the toe and along the batter only. Considering the limited lateral flows, scour protection has not been considered at the top of the batter. Instead, only rock sizing has been considered. The rock armouring design used existing survey data and did not consider earthworks or net-filling.

The channel bed scour protection design for Copper Creek bank used a K value of 0.86 for supercritical flow. Angular riprap will be used with a minimum specific gravity of 2.6. The maximum size of riprap will not exceed 1.5 times the calculated d50 riprap size. Riprap will be placed on the bank over geotextile at a minimum thickness of 2 times d50 with a key-in at the toe of the bank. Maximum bank slopes will not exceed 1V:2H.

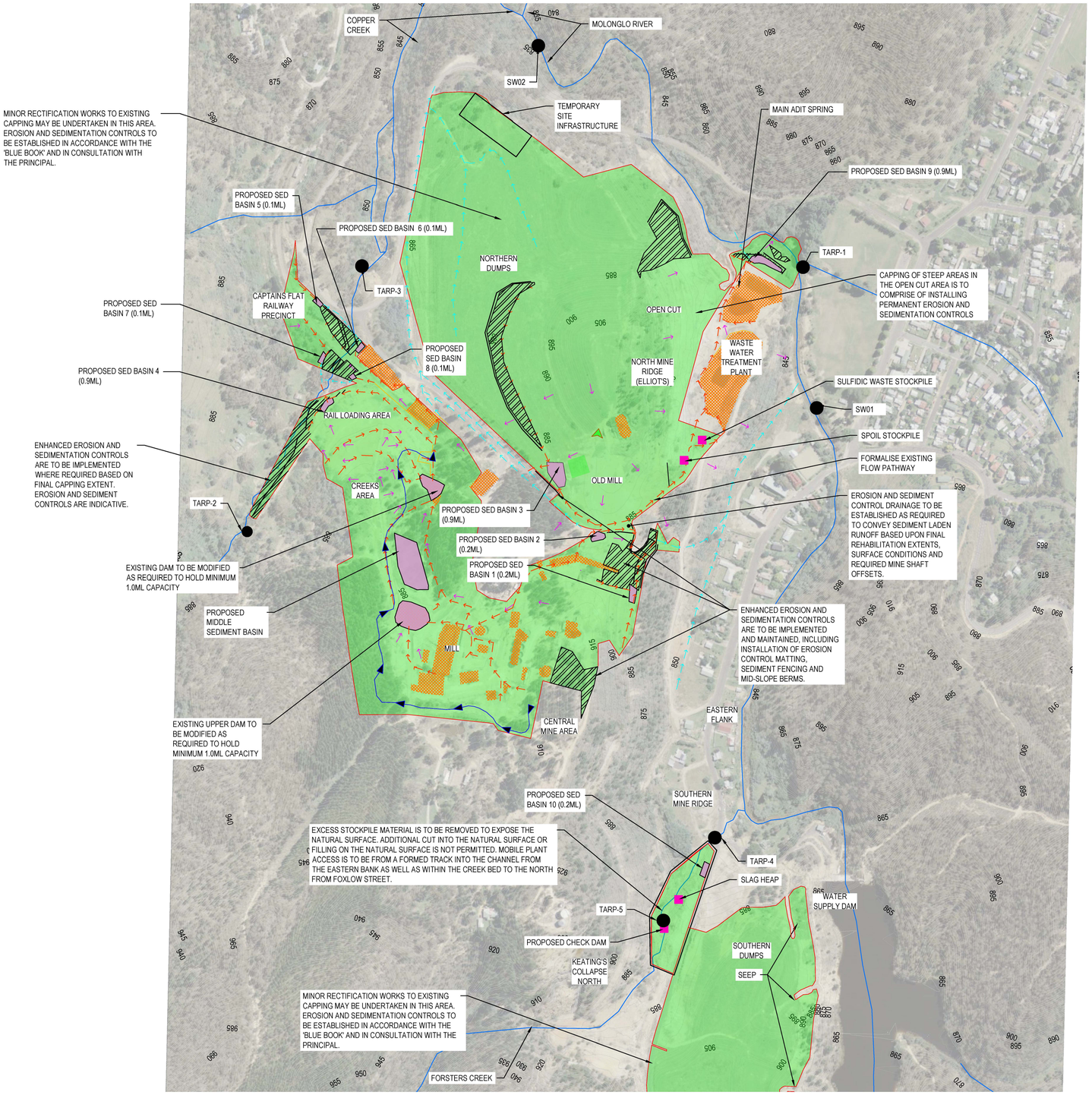
The works area was reviewed against the 1 in 20 AEP HEC-RAS modelling results to identify flood velocities along the bank. Several cross sections have been considered dependent upon maximum calculated flow velocities along bank as follows:

– Type A: For velocities less than 1.9 m/s a 200 mm d50 is acceptable
– Type B: For velocities between 1.9 and 2.5 m/s a 300 mm d50 is acceptable
– Type C: For velocities greater than 2.5 m/s a 300 mm d50 is acceptable with 400 mm d50 at the toe of the slope (this arrangement is based on a worst-case site-specific cross section with a peak velocity of 3 m/s at the toe of the bank which then decreases as you progress up the bank).

The type of channel armouring required is shown in a layout plan contained in the drawings in Attachment 1. It assigns the type of channel armouring required based on the flood velocities (from the flood model) in the works area. The modelling identified the use of predominately Type A armouring, with minor use of Type B armouring. Based on the final extent of works, Type C armouring was not required.

Attachment 3

Conceptual Surface Water Management Plan



LEGEND

- SURFACE WATER FLOW DIRECTION
- HYDROLINES
- TEMPORARY SEDIMENT DRAIN
- EXISTING FLOW PATH
- CLEAN WATER DRAIN
- REHABILITATION AND CAPPING EXTENTS (APPROX.)
- EXISTING INFRASTRUCTURE
- MAXIMUM EXTENT OF REMEDIATION
- TARP MONITORING LOCATIONS
- SEDIMENT BASINS
- SEDIMENT FENCING
- BUNDS
- AREAS REQUIRING ENHANCED SEDIMENT AND EROSION CONTROLS
- EXISTING 1m CONTOURS

NOTES:

1. EROSION AND SEDIMENT CONTROLS SHOWN ARE THE MINIMUM REQUIREMENTS. THE CONTRACTOR SHALL IMPLEMENT AN EROSION AND SEDIMENT CONTROL SYSTEM AS PART OF THE CONSTRUCTION MANAGEMENT PLAN IN ACCORDANCE WITH MANAGING URBAN STORMWATER - SOILS AND CONSTRUCTION MANUAL (DECC, 2004).
2. SEDIMENT BASINS TO BE DESIGNED TO PROVIDE FOR 85TH PERCENTILE 5 DAY RAINFALL CAPACITY IN ACCORDANCE WITH THE REQUIREMENTS OF MANAGING URBAN STORMWATER - SOILS AND CONSTRUCTION MANUAL (DECC, 2004)
3. DRAINAGE CHANNELS GENERALLY TO COMPRISE GRASSED SWALES LAID ON EROSION CONTROL MATTING AND UNDERLAIN BY TOPSOIL
4. ALL DRAINAGE TO BE CONSTRUCTED WITH MINIMUM 1% LONGITUDINAL FALL.
5. LOCATIONS OF EXISTING DRAINAGE AND CULVERTS ARE INDICATIVE ONLY AND TO BE CONFIRMED ONSITE
6. ALL CAPACITIES AND SIZINGS ARE INDICATIVE ONLY AND SUBJECT TO DESIGN.
7. TEMPORARY CLEAN WATER DRAINS TO BE IMPLEMENTED AS REQUIRED, IN CONSULTATION WITH THE PRINCIPAL TO MINIMISE DISTURBED AREAS REQUIRING EROSION AND SEDIMENTATION CONTROLS.

SURFACE WATER MANAGEMENT CONCEPT PLAN

SCALE 1:3500

Rev	Description	App'd	Date
0	CONCEPT PLAN		22.12.14

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Scale for A1

DEPARTMENT OF REGIONAL NSW
LAKE GEORGE MINE REMEDIATION REF
SURFACE WATER MANAGEMENT CONCEPT PLAN

Size A1

Status code S4 | Project No. 12551771 | Sketch no. FIGURE A1 | Rev no. 0

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The Power of Commitment